THE ENGINEERING MAGAZINE

VOL. XXI. JUNE, 1901. No 3.

BRITAIN AND HER COMPETITORS IN IRON AND STEEL MAKING.

By E. Phillips.

Mr. Phillips' first article appeared in the May number of THE ENGINEERING MAGAZINE. It was devoted to a brief but comprehensive review of the contrasting physical and economic conditions affecting steel production in Britain and the United States. He showed that superior natural resources, and, above all, intense application to the use of mechanical appliances and labour-saving methods, give America an average advantage of £1.5, or $6.25, in the cost of a ton of steel. He now takes up the possibilities open to Britain for reducing this disparity.—THE EDITORS.

PHYSICAL conditions seem greatly to favour the United States in the competitive struggle for dominance in the steel industry, and these advantages have been utilised, as reviewed in detail in my preceding paper, with the utmost ingenuity and mechanical skill in working out economies in mining, transport, and smelting practice. It remains to consider how far and by what means it is practicable to modify the extra charges paid in Britain by the steel maker—how royalties, wayleaves, land payments, and ground rents affect unfavourably the cost of making steel.

There are some costs, in the present state of the laws and customs existing in Britain, with which the British manufacturer will be permanently handicapped, but from which Americans are exempt. Such are the landlords' royalties and wayleaves of from 6d. to 1s. per ton on all minerals, a lesser amount for limestone used for flux and for stone

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and clay for building purposes; payment for land surface on which to build works; and payment for surface land with permission to sink pits and to expend large sums of money to dig down into the bowels of the earth for minerals. The landlord makes it a condition that he shall not be called upon to pay any local rates on the amount of royalties and wayleaves paid to him, or on the ground rents he imposes for houses built in colliery and works districts, or in towns and shipping ports, inhabited by those engaged in the manufacture of iron and steel, its transport on railways, or its disposal at points of shipment. All this means that workmen have to be paid more wages, and employers must add in proportion to their selling prices in order to pay these landlord imposts. Further, the landlord makes provision that his leases of houses, built to form village communities and towns to carry on trade, are granted for a limited number of years only. The lessee agrees that the houses shall be kept in repair and insured against fire, and at the expiration of the lease the landlord "annexes" the house, place of business, or works premises, with its increased commercial value created by the lessee during the period of the lease, without any payment to this lessee. For the future he collects the full increased rental of such premises, instead of the ground rent he previously received. This in plain language is nothing less than a legal permission for landlords to appropriate to their own use other persons' property, with the increased value of the business their industry created. The increased rental may be from ten to twenty times that of the original ground rent, according to what may have been the growth in the business value of the district.

It may be said: "What has this to do with the making of iron and steel?" It has very much to do with it. Take the case of a workman's house costing, say, £150. The certain expiry of the lease at the end of a given number of years, and the absorption by the landlord of the capital invested without compensation at the end of the lease, mean this: that the builder has to obtain the capital he has expended, interest thereon, and cost of repairs, by charging an additional rent to the tenant (to recoup himself during the period of lease) of from 2s. to 2s. 6d. per week, more than if this landlord impost did not exist. Thus extra wages have to be paid by the manufacturer, for the workman must have a living wage left. In this way terminal-lease conditions become an additional percentage tax on the wages of all men engaged in connection with the industry, from the mine to shipping port. Putting it in another form: assuming that the average wages earned by a man are 30s. per week, and that 2s. extra rent has

to be paid; this means that 8 per cent. of the workman's wages go to the landlord, and in case the extra rental is 2s. 6d., 10 per cent. of his wages are so absorbed.

Further, large amounts have to be paid the landlords for the land over which railroads have to be made, and land for docks and wharves at shipping ports. This, again, is equivalent to another royalty for being allowed to bring products to market for distribution. The marvel is, that the ancestors of landlords did not also make provision that the same English law which enables them to make the foregoing imposts, should have conveyed a similar legal right to impose a royalty poll-tax on employers and men employed for the privilege of breathing the atmosphere above. There is no reason why they should not have the same proprietary ownership of the atmosphere above the land as of the minerals below, and charge for breathing, utilising, and absorbing it, just the same as they already by law charge for the land and minerals below. But this was no doubt an oversight on the part of the landlords' ancestors.

The Removal or Minimisation of Royalty Imposts:—The nationalisation of land, so as to do away with all royalties, wayleaves, and ground rents, from which other countries are exempt, is too large a question, and is beyond the range of practical legalisation in this generation. What is wanted is prompt and immediate relief. A great deal is said as to sacredness of private ownership of property, and of agreements come to between landlord and tenant in the granting of leases, to pay certain royalties and wayleaves for working minerals and ground rents for houses; but it must be borne in mind that these agreements are very much of a one-sided nature. The lessee of works, minerals, houses, has no option but to accept the landlords' terms, and his other conditions which give him the right to appropriate without payment such property built on his estate at the termination of lease. If the lessee should say, "Such conditions are not right or fair," the landlord replies: "Then if you object to my terms you shall not work the minerals on my estate, or build a house on my land." Putting it in this form, it is at once seen how unfairly one-sided such agreements are.

If Parliament, in its wisdom, finds it necessary in the interest of the welfare of the nation to remove or modify ancient privilege laws to landlords in relief of trade burdens, there is nothing to prevent this being done; there is no such thing as the absolute ownership, either of land or personal property, except so far as it may not be detrimental to the general welfare of the nation. Take the case of the

wealth a man may accumulate in his lifetime. What does the State do? The sacredness of absolute ownership is not recognised. One man accumulates during his life personal property amounting to £1,000, another £1,000,000, whilst the third accumulates £10,000,000. The State says to the representatives of the deceased who died worth £1,000: "You shall not be absolute owners of all the money the deceased saved; one per cent., or £10, must be paid back to the Nation." To the others representing the £1,000,000, "you must refund 10 per cent, or £100,000." To the executors of the third, valued at £10,000,000, "you must also refund 10 per cent., amounting to £1,000,000, to the State."

It is to be noted that up to the time Sir William Harcourt brought in his celebrated Deceased Legacy Duty bill in Parliament, the landlords, with their well-proven shrewdness, had taken good care that they should be exempt from paying legacy duty on land values of their estates, paying only on the value of their personal property; but Parliament in its wisdom changed this law. The result is that the representatives of deceased landlords' estates in land have now to repay to the Nation annually large sums, which they previously pocketed by the protective exempting law they had created. Parliament having done this, there is no reason why they should not also pass a "Relief Royalty and Ground-Rent" bill cancelling the present iniquitous provision in leases permitted by the present law. This would minimise the burden of these imposts on iron and steel industries.*

What I propose would be a short bill, with only a few clauses, which might be passed at the next Parliament without disturbing existing royalty mineral leases, leases of works, ground rents, or leases for houses and buildings. The two clauses should reduce royalties and ground rents to one-third, or one-half, of what they now are. Here is my suggestion.

1.—All royalties and wayleaves on minerals, rents of land for works, docks, railways, etc., together with ground rents for houses and business premises, etc., shall be subject to local taxation, the same as other rateable property.

2.—All these royalties, rents, etc., above named, shall also be subject to an additional imperial tax of 25 per cent. of such payments in

* At the time of the passing of the Reform bill of 1832, Pitt brought in two bills, one to tax personal property, the other landed property. At that time every member of Parliament was a landlord. These patriotic gentry passed the bill taxing the business man's personal property, but threw out the bill to tax their own landed property. This exemption continued till the passing of Sir William Harcourt's bill.

relief of national burdens, which indirectly would relieve manufacturers in all trades.

It may be said: If this were done, what is to prevent the landlord in all new grants for minerals or of ground rents for houses and places of business, from charging increased royalties and ground rents to recoup himself of what the new law made him pay?

This I should check-mate by a few simple clauses added in the bill, viz.:—

3.—In the case of royalties of minerals, let after the passing of the bill, no larger royalty amount shall be charged nor for land required than the customary one paid previously in the respective districts, on a basis of an average of the amount at which it was let during the previous ten years for similar minerals and land.

4.—In the case of ground rents, there shall be no increase of that charged for buildings recently erected, the average of that of the previous ten years to be the standard.

These two clauses would prevent any additional imposts at any future time or the continuance of the annual increased increment to landlords, which would remain at what it was at the time when this act became law.

Then as to the appropriation of property in houses, at the termination of the lease, I would have the following clause:

5.—At the expiration of all leases it should be compulsory upon landlords to grant a new copyhold perpetual lease, and in lieu of the landlord's right under the lease to "annex" such houses without payment, he should be paid an increased ground rent, on the following basis: If, say, the original ground rent in the lease was at that time £3 annually for a house letting at £21, and if by the end of the lease the ground rents for similar allotments had gone up to £10 and the rent of the house had also gone up to £100, then instead of the landlord being allowed to appropriate the property and receive the £100 a year, for premises for which he was before receiving £3 annually, he should receive the increment growth of ground-rent values during the period of the lease, which in this case would be £10, instead of the £3 under the lease; the ownership of the property clause at the expiration of the lease being cancelled, and the increased present ground-rent value only payable for all future time.

This change in the law would be only similar to that which was made in recent years in another form, in the case of a landlord's estate in land valued at say £1,000,000, for which deceased's successors were exempt from paying legacy duty, but have now to refund back

to the Nation one tenth of it, amounting to £100,000. The relief here specified could very considerably ease royalty charges by lessening the burden of local taxation, and in course of time would lower workmen's wages, as well as national taxation, and change the spoliation of the capital value of buildings by the landlords at the termination of the lease to the receipt of an increased ground rent, as indicated.

British Railway Rates. No material relief is to be expected by a reduction in tolls, works in the north of England being on the seaboard, and in Wales but 20 to 25 miles inland. Still, even in this the monopoly enjoyed by railway companies enables them to charge excessive rates, so as to pay large dividends.

Continental railways are generally owned and worked by the State, and the rates are much lower than in Britain. Take the case of the year 1895 as a typical one, when coal was at a normal rate, which that year averaged 6s. 5d. per ton. If the number of tons carried be divided into the income earned for carrying the coal, it works out 1s. 7½d. per ton. German and Belgian railways, carrying the same quantity the same distances, would make rates of less than 6d. per ton, or 1s. per ton difference. Besides this, there is the anomaly of British railways carrying foreign goods consigned to the country at from one-half to two-thirds less than home goods, thus giving a premium to the foreign shipper. Astonishing as it may be to the reader, yet it is an absolute fact, such is America's advance in the movement of traffic on railroads, that it does not cost the Carnegie Co. more to take their ore from Lake Erie to Pittsburg, a distance of more than 150 miles, than it does in Wales to take the ore the short distance of a little over 20 miles. I question if it costs as much, and for illustration give the facts:—The powerful Carnegie engines of 127-tons' weight take from the Lake port to Pittsburg thirty wagons carrying 50 tons each of ore, 1,500 tons at one time; the tare of these 50-ton trucks is only 15 tons each, the total dead weight being 2,100 tons. If this 1,500 tons was required to be sent, say from Newport to the Blaenavon or Ebbw Vale Works, some fine morning (and about the same would apply from Cardiff to the Dowlais and Cyfarthfa works) how many 10-ton trucks would be required to take the 1,500 tons and how many engines would have to be brought out of the sheds to start, one after the other, with this 1,500 tons of ore? It would require one hundred and fifty trucks, the tare of each being 5 tons. The engines employed could not take right through to works more than 150 tons each of ore in fifteen 10-ton trucks, so that it would require *ten engines* and

thirty men, with a dead weight of ore, trucks, and engines of about 2,500 tons, to do the conveyance of the 1,500 tons, which is done in America with *one* engine and three men only. Consider what the extra wages must be for twenty-seven more men engaged to do the same work, and the extra coal and stores used by ten engines instead of those required for one engine. The extra time taken to go the longer distance would have to be taken into account. This is the kind of thing that goes on (more or less) to ensure dispatch and quantity in all departments from the mine to the mill in America.

The relief from these costs can be obtained only by the removal of the Welsh works to the seaboard, where they may have ample space (which is not available in the narrow valleys where works are located) and elbow room to marshal supplies and arrange production so that the ore may be taken direct from steamer to furnace close at hand. This has already been done by the Dowlais Company for a portion of their works, in close proximity to the Cardiff Docks, where further extensive plant and latest improvements is in course of being introduced. Similar developments have also been carried out at the Moss Bay, and other works in the north of England.

What British Manufacturers Must Do to Reduce Costs. New capital must be forthcoming to erect new and re-construct old works, with furnaces and plant of latest type, utilising every electrical, hydraulic, and mechanical labour-saving appliances, so as to ensure great dispatch and a large production, which of necessity will mean fewer hands employed for an equal tonnage.

The Question of Difficulty with Men and their Unions. Unfortunately for the men, for the time being, the new methods will dispense with the employment of a considerable number, their previous work being done mechanically. The employers will no doubt have great difficulties with English workmen and their unions, in the introduction of methods curtailing the number of men to do the work; but in this inquiry, we have to set aside the question of how many or how few men are to be employed. The fundamental question is: What are the conditions under which America makes steel at such a low price, that she can undersell the English manufacturers in their own home and in foreign markets previously supplied exclusively by them?

If men and their unions will not co-operate by working with labour-saving methods, so as to ensure as far as possible reduced costs, how is it possible for employers to compete with America? Orders will go elsewhere and works be closed, and the need of their employ-

ment would cease. Whether the men realise it or not, England is face-to-face with a commercial war of competition with America and Germany that will tax her best energies to retain at all even a goodly share of her previous markets for steel (as well as for all other manufactures), and the next decade will see a far greater retrogression and falling off of trade than in the last, unless every means that science and mechanical skill can devise be allowed to have a free scope, and the co-operation of all men be given, notwithstanding that the number employed may temporarily be fewer. It would be nothing less than commercial suicide on the part of the men and employers not to profit by the study and the practical application of what is done by other countries. The policy of the men and their unions in the past has been to resist the introduction of labour-saving machinery that would increase production at a lower cost. But experience in all such mechanical revolutions has been that, whilst for the time being numbers of men may be displaced, in the long run more men have been employed than previously, for the simple reason that cheap production creates a greater demand for an increased quantity. The policy of the men and their unions has been to restrict production, to do less work, but to demand more pay and work fewer hours. The American policy is the opposite to this. The men work harder there than in England, work longer hours, and go in for the greatest output that their powerful machinery makes it possible to turn out. And in doing so they earn much higher wages than in England. And this policy on the part of the employer in equipping his mines, of the engineer in the design and introduction of machinery for rapid production and transportation, of the men in complete co-operation combined with the highest technical and scientific knowledge, accounts for the advantages the United States possess for producing cheaply and underselling others who continue working on antiquated lines.

Suggestions for the Reduction of Cost of Ore and of Freights. At present an average of 5s. per ton more is paid to Spanish mine owners than it costs the American at Lake Superior, with another 2s. 6d. more for freight for transportation to England. This, for the two tons of ore necessary to make a ton of steel, runs the extra cost for ore to 15s. per ton on the finished product. This, of course, does not apply to manufacturers in the north of England and Scotland, who work their own ore mines and have no freight to pay, and to that extent they are able to make steel cheaper than those using imported ore from Bilbao. A reduction in the cost of ore and freight is possible under the following conditions:

First:—Direct reduction in price of ore, by the acquisition of Spanish mines.

Second:—Raising the present maximum of 0.025 per cent. of phosphorus in imported ore to 0.050 per cent., as in America.

Third:—Lowering freight by improved shipping facilities at Bilbao, and at ports of delivery.

1:—Acquisition of the Spanish Mines. To accomplish this British manufacturers should combine to form a powerful mine trust, with ample capital, to secure Spanish mines by purchase or such other arrangement as may be made with the numerous mine owners, (making a combine of the group, as was done in the case of the gold mines of the Transvaal), and further to secure the rights of working other large well-known areas of ore inland, and to make railways from these to tidewater. This has already been done to some extent by individual firms, such as the Dowlais Co., Cammell & Co., Consett & Co.; but for the larger scheme it would no doubt be possible to arrange with these firms to join in the formation of a combined mine trust. The apportionment price of the different qualities is one of detail which we need not here consider. By such a combination, the price of ore would not be subject to present fluctuations, such as during the recent boom, from 7s. to 14s. at Bilbao. The present large profits made by Bilbao mine owners would to a great extent be saved. By such a combination the cost for ore on board at Bilbao would be very much less than at present.

(2)—Standards of Phosphorus Contents. American manufacturers accept ore containing 0.045 per cent. to 0.05 per cent. of phosphorus, their maximum in good finished steel being 0.10 per cent. of phosphorus and 0.10 per cent. of carbon. Steel rails, tin-plate bars, girders, ship plates and angles, merchant bars, and engineering work of all kinds, with this maximum of 0.10 per cent. of phosphorus, are accepted by buyers in Britain and all the world over. On the other hand, British manufacturers are at present tied down by the stipulation that delivery of steel will not be accepted except on the basis of 0.06 per cent. to 0.07 per cent. maximum of phosphorus. The effect of this in the past has been that they could not accept imported ore, except on the basis of 0.025 per cent. of phosphorus, under heavy penalties.

It appears that an eminent chemist some years ago gave it as his opinion that the maximum of phosphorus and sulphur in good steel should not exceed 0.06 per cent. of each, and 0.10 per cent. of carbon, and to this standard British manufacturers have since had to conform.

But I am informed by a local consulting chemist of well-known repute, who also has a practical knowledge of the working and management of blast furnaces, that many years ago he had determined by chemical investigation, and had so advised manufacturers, (as also later on had other chemists), that good steel may contain 0.10 per cent. of phosphorus, 0.05 per cent. of sulphur, and 0.10 per cent. of carbon; but not more than 0.05 per cent. of sulphur and 0.10 per cent. of carbon; as it is desirable, in the case the phosphorus runs up to 0.10 per cent. in finished steel, to have as much less than 0.10 per cent. of carbon and 0.05 per cent. of sulphur as possible (more especially less of sulphur). This has now proved to be correct by the fact that American steel of the chemical contents of 0.10 per cent. of phosphorus is used for all purposes in the States, and is accepted both in Britain and in other countries. Yet British makers are restricted in their productions to 0.06 per cent. of phosphorus.

We are informed that the American soft steel will not bear deep stamping, such as British steel will readily do.

The first thing British manufacturers should do, and at once, by an united combination, is to insist that buyers should accept British-made steel of the same maximum—0.10 per cent. of phosphorus—as they do American.

The result of this change (raising the standard of phosphorus in steel to 0.10 per cent.) would be that the British manufacturers would be able to use ore of 0.045 per cent. to 0.05 per cent. instead of being confined, as now, to 0.025 per cent. There are many millions of tons of ore at Bilbao in the numerous mines now rejected, ranging from 0.03 per cent. to 0.05 per cent., which may be obtained at a very low price. This would very materially reduce the price now paid, as miners are now restricted to select ore of 0.025 per cent. contents.

Something need be said also, respecting the British manufacturers' stipulation that ore shall not contain more than 0.025 per cent. of sulphur. I am informed by the chemist above referred to that there is also no justification for the stipulation of a penalty if ore contains more than 0.025 per cent. of sulphur, providing it does not exceed 0.05 per cent., for the simple reason that, unlike phosphorus, (none of which is eliminated in the blast furnace), a great portion of sulphur is eliminated if the furnace is in good working order, as it always should be; no injury, therefore, will result to the steel if the sulphur in the ore does not exceed 0.05 per cent. The new maximum standard for both phosphorus and sulphur in ore may, therefore, be raised from 0.025 per cent. each to 0.05 per cent. each.

Improved Facilities at Bilbao and at Ports of Discharge. To reduce present rate of freights, the proposed combination should have increased tips and improved methods for the more rapid loading of steamers. These should be provided also at ports of delivery, although it may be impossible to do at Bilbao what is done at Lake Superior, where a 6,000-ton boat is loaded in less than a day—in fact, in a few hours. Still, it is quite possible that a 2,000-ton steamer could be loaded in one half the time now taken. At present a condition of the charter is to load and discharge at the rate of only 300 to 400 tons a day; if this were raised to 1,000 tons, loading and discharging by improved shipping and discharging arrangements, ship owners could accept at least 6d. per ton, if not 9d. per ton, less freight, being well reimbursed in the ship's time, wages, etc., saved. When it is considered that this would mean 1s. to 1s. 6d. less for freight on every ton of steel, it will at once be seen that an expenditure for such facilities is of the first importance.

It may be fairly assumed that a mine trust, working their own mines and making improved shipping facilities, after allowing a moderate interest on capital invested, would obtain their ore at from 5s. to 7s. 6d. less than it now costs them, which would mean 10s. to 15s. per ton of steel.

Saving in the Price of Coke. Antiquated modes of making coke should be done away with, and the bye-product system should be adopted, as is now the case in the best up to date foreign works. The utilisation of gas and sale of the bye-products very largely, if not altogether, pays for the coke.

The proverbial conservatism of Englishmen in the past has had much to do with their delay in accepting the new conditions in good time, retarding, rather than adopting, new methods, preferring to stick to the old ruts. It is to be hoped that the necessities of the competition, which has threatened to overwhelm them, will convert them to the adoption of a more progressive policy for the future: otherwise their former pre-eminence as iron and steel makers will very shortly come to an end.

American Inroads on the British Tin-Plate Trade. During the past decade, quite a revolution has taken place in shifting the manufacture of tin plates from England to America.

Ten years ago, America took 75 per cent. of the British make, amounting to something like 6,500,000 boxes annually; this has now fallen off to 1,250,000 boxes, and the fraction has been retained only by the arrangement to allow back on re-exportation a rebate of 9*d* per

cent. for plates used in the petroleum, fish, and fruit "canning" business.

The growth of this industry under the McKinley tariff is seen when we note that in the year ending June 30, 1892, the American make was 13,646,719 pounds (124,000 boxes) but for the year ending June 30, 1899, their make was 791,371,438 pounds, or 7,327,500 boxes. Now the Americans contemplate absorbing the 1,250,000 boxes at present supplied by Britain, for the canning business. Indeed, they have already begun doing so, for it is clear that if the Americans can afford to send bars to England to make tin plates at a cost of more than £1 per ton, to be sent back for their canning trade, they could make these plates in their own works, as the 25s. to 27s. 6d. per ton they now pay to send bars to Wales would cover the extra wages in mills and tinning departments. As a matter of fact, the tariff is not now necessary to keep out this trade, nor to protect the general American home trade. The tariff is now really retained to enable iron masters to charge a high price for bars to the tin-plate makers, and by so doing swell their large profits, which of course their own home consumers have to pay.

American and British Tin-Mill Output. An illustration of the same differences I have traced throughout the iron trade, as they affect the output in mills, will be interesting. The British mill men and their unions restrict the output to thirty-six boxes per 8 hours, or one hundred and eight boxes per day, whilst the American mill men, with their powerful machinery and mill plant, produce sixty boxes and even seventy-five boxes in each 8 hours, or over two hundred boxes per turn. Think what this means. In Britain the maximum make is six hundred boxes per week, whilst in America it is twelve hundred boxes per week, *one* mill plant and *one* set of men doing the work of *two* English mills and *two* sets of men, with the additional extra costs for coal, and doubling of all fixed expenses.

A further movement contemplated on the part of the American tin-plate trust is to obtain their tin direct from the Straits Settlements, by an arrangement with the producers, the quantity now used in America for coating tin being 10,000 tons annually. At present both British and Americans have to purchase their requirements from the London tin merchants, who import and control the price to be paid for tin, so much so, that we have seen the price fluctuate from £50 to £160 per ton, a different ranging from 6d. to 1s. 6d. per pound, and during the recent boom it has ranged from £75 to £145. The tin-plate makers, being at the mercy of the London tin operators, pay the price

they demand. It is evident that the cost of obtaining the tin is much about the same at all times. It would be safe to assume that the proposed tin-plate corporation would secure their 10,000 tons annually at £20 per ton, less on an average, than is paid as it is now obtained. This would be over 2d. per pound, and as nearly 3 pounds is used for coating a box, the saving in tin would be 6d. per box. This, combined with their cheap production of tin bars, notwithstanding that they have to pay considerably more wages per box than in Wales, would enable the American tin-plate trust to come into competition with England, during the current decade, for a share of the outside world's requirements. Of course, it is quite possible for English tin-plate manufacturers to form a combine for the same purpose, and this they should do in self defence, but will they do so? I fear not; past experience of co-operation in other directions has been anything but satisfactory, chiefly from the outcropping of selfish motives and the impossibility of harmonising financial considerations.

New Works at Sydney, Cape Breton. It has long been known that immense tracts of rich ore and coal existed in Canada, in convenient proximity to shipping ports. Extensive areas have been secured by The Dominion Steel and Iron Company, with a capital of $20,000,000, who already have four up-to-date blast furnaces under construction or at work, of the latest type and large dimensions. Also a number of open-hearth furnaces, a 35-inch blooming mill, pit furnaces, four hundred Hoffman coke ovens, a coal-washing plant, and large machine shop and foundry, all combined capable of developing the largest output. At a meeting of the directors recently held at Montreal, it was decided to proceed at once with the erection at Sydney of plant for the manufacture of steel rails, bars, and ship plates.

The company have also decided to issue new capital for the purpose of establishing a large ship-building business at Hamilton, some 150 miles from Sydney. Sydney is destined to be one of the greatest shipping ports of Canada, the largest steamships built being able to get alongside the stages of the works at all states of the tide.

The company has also provided against any difficulty connected with the closing of the port by ice for a short period in winter, by connection of their works by railway with the harbour of Louisburg, which, though distant from Sydney but 22 miles, is open all the year round. Six steamers are being built to carry coal between Louisburg and Boston, U. S. A.

The ore at furnaces is said to cost only 4s. per ton, coke 6s., and limestone 2s. 3d., and works out as follows:—

1.80% Ore to the ton cost	$1.80		
1.25% Coke to the ton cost	1.80		
75% Limestone cost	.40		
Labour, repairs, etc	1.50		
	$5.50	equal to	£1.3.0
Conversion into steel	5.00	equal to	1.1.0
	$10.50	equal to	£2.4.0

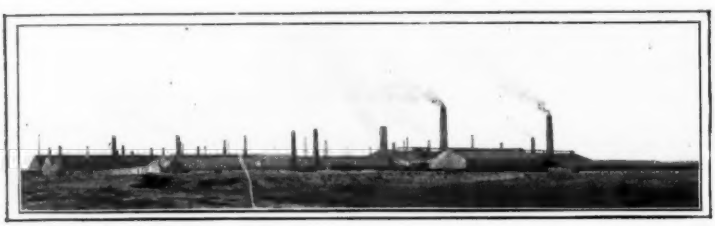
The comparison with costs in the United States and England will therefore be as follows:—

	Cost of Pig.	Cost of Finished Steel.
In Britain	£2.10.0	£3.15.0 (in normal times)
In America	£1.10.0	£2.10.0
In Canada	£1. 3.0	£2. 4.0

The advantage the Canadian new works possess over those of the United States is that their coal and ore are in close proximity to furnaces and can be moved at one handling entirely by cheap water transport, with no transportation of the products to port for exportation. With this they combine a very cheap cost for mining.*

The natural conclusion from what has been advanced in this paper is that with further extensive developments likely to take place during the next ten years, we shall find Canadian works competitors with America, Germany, and Britain for the steel requirements of the world.

* THE ENGINEERING MAGAZINE has in preparation a complete illustrated account of this significant enterprise, with data of the ore supplies and their quality, character of the fuel, and other points of importance. The paper will appear in our July issue.



TURBINE BUILDING AND TURBO-ELECTRIC STATIONS IN SWITZERLAND.

By Franz Prášil, Professor at the Federal Polytechnic Institute in Zürich.

The first section of Professor Prášil's review, published in our May issue, was concerned with the rise of turbine building in Switzerland, the equipment and capacity of the great turbine-building works, and the hydro-electric installations erected since 1889. These plants at Berne, at Zürich, on the Aar, at Rathausen, and in Zufikon-Bremgarten, by consecutive advances in successful practice, led up to the important stations described in this concluding paper.—THE EDITORS.

BETWEEN 1888 and 1889, as shown in my preceding article, may be found a starting point of modern progress in hydro-electric engineering in Switzerland—the first appearance of stations containing a number of similar units. The earlier of these—those at Geneva, Zürich, Schaffhausen, Berne, the plants on the Aar, and the stations at Rathausen and Zufikon-Bremgarten—have been already referred to. I reserved for this paper the description of the stations at Chèvres and Rheinfelden. The energy, perseverance and thoroughness with which the whole question had been studied are proved alone by the fact that, without the experience to be gained by a gradual transition from smaller enterprises, people had the courage to begin the work for the utilisation of such an enormous amount of energy as 22,000 horse power, and this in the face of the difficulties due to a comparatively small and, at the same time, widely varying head of water. For there can be no doubt that it would have been very difficult to raise the large amount of capital required for this undertaking, if the plans had not clearly shown the probability of their realisation.

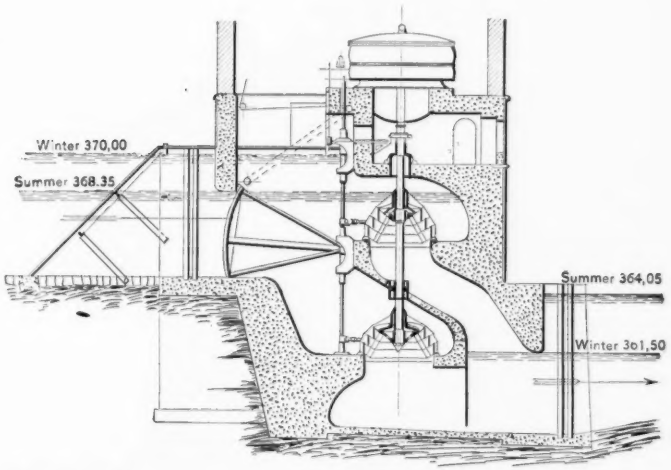
The Chèvres plant is about 6 kilometres (3.7 miles) downstream from Geneva, and is designed to use the water-power available at this point to generate electrical energy for Geneva and its vicinity. The water supply is furnished by the Rhone, which has already been regulated by the Coulouvrienniére installation, and by the Arve, with its widely varying volume. The water-power is made available by means of a sluice-weir, Figure 9, and a head-race 136.5 metres (448 feet) long leading to the turbines. The weir has seven sluice-gates,

each 10 metres (32.8 feet) wide and 8.5 metres (27.9 feet) high, which are built between piers, each 17 metres (55.8) feet long and 3 metres (9.8 feet) thick. Each gate weighs 50 tons and has a water pressure on it of 360 tons, and the whole weir forms a structure of great strength. In winter, when the volume of water is 120 cubic metres (4,240 cubic feet) per second, there is a head of 8.5 metres (27.9 feet), whereas in summer with 900 cubic metres (31,800 cubic feet) per second, the head is only 4½ metres (14.8 feet). The tail-race is formed by a wall starting at the dam, and built in the bed of the Rhone, 130 metres (430 feet) long, 2 metres (6.5 feet) thick and 4 metres (13 feet) high.

FIG 9. THE WEIR AND GENERAL VIEW OF THE CHÈVRES PLANT.

In order to operate the sluice-gates, a steel bridge was erected on the piers, and the lifting mechanism was attached to the trusses. This part of the installation was designed by the English engineer, Stoney; the steel work was carried out by the firm of Schmidt, and the lifts were built by Piccard & Pictet, both of Geneva.

The turbine house, which lies nearly parallel with the river, has a length of 136.5 metres (448 feet) and a width of 12.5 metres (41 feet) and is designed to accommodate 15 principal turbines with their directly-coupled generators. The building also contains two 150-horse-power turbines with directly-coupled continuous-current exciting machines, besides all the apparatus for distributing the current, a complete pumping and filter plant for oil, a workshop, and several offices.



The building foundations, the bridge piers, the tail-race wall and the works for protecting the river bank are all built of concrete, resting on sandstone.

Of the fifteen turbines, supplied by Escher Wyss, five are of an

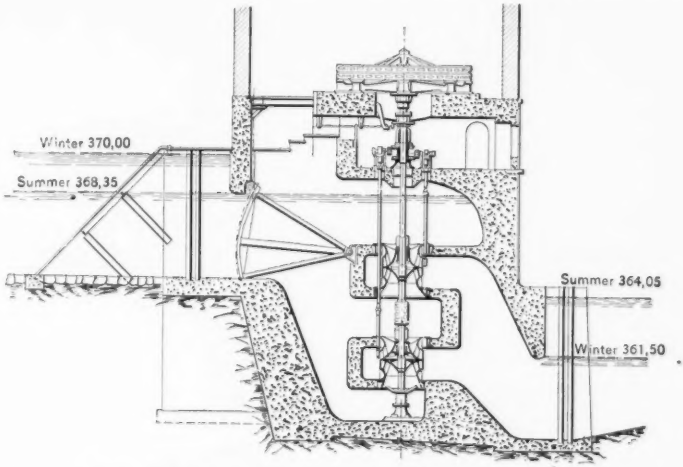


FIG. 10 HYDRO-ELECTRIC STATION AT CHÈVRES, NEAR GENEVA.
The upper view shows the turbine arrangement of the old installation; the lower one shows the new turbine plant. Built by Escher Wyss & Co.

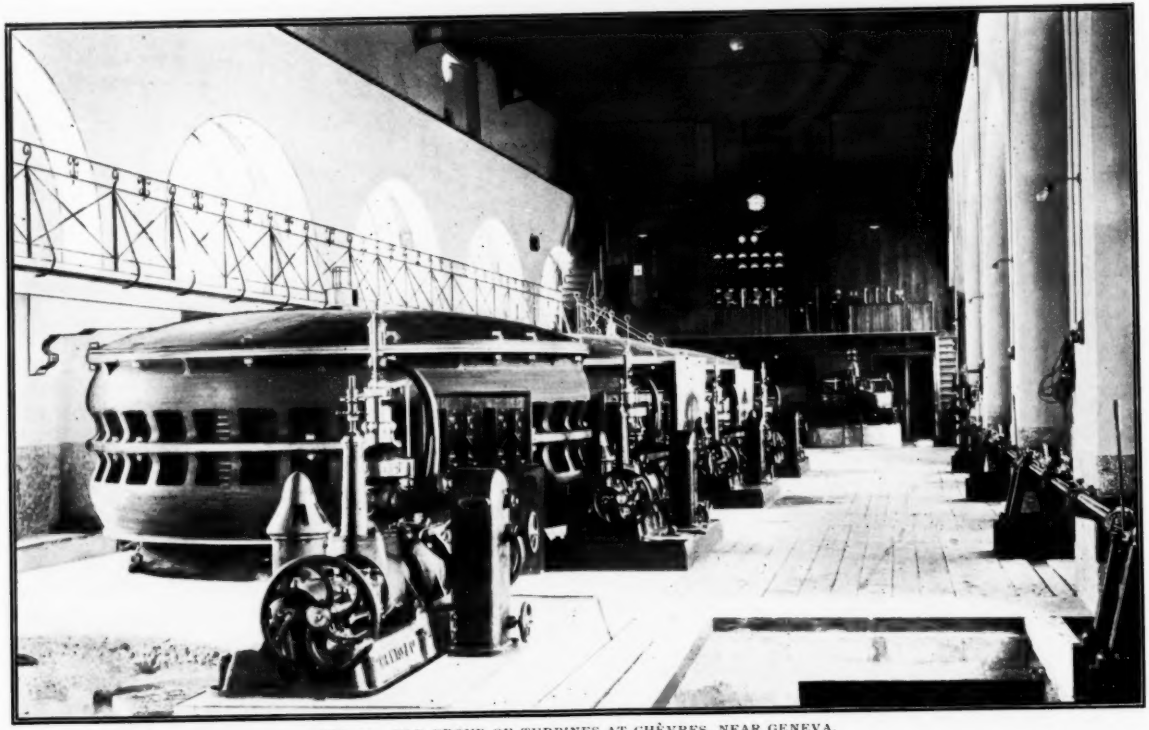


FIG. 11. OLD GROUP OF TURBINES AT CHÈVRES, NEAR GENEVA.

FIG. 12. NEW GROUP OF TURBINES AT CHÈVRES, NEAR GENEVA.

older construction and the remaining ten of a modern form, as may be seen by Figures 10, 11, and 12.

The older turbines are double ones, as two wheels are keyed to one and the same shaft, each with its own guide-blades. The water chamber of each of these double turbines is divided into two parts by an S-shaped concrete-steel diaphragm, so that there is an upper turbine and a lower one, which, except for their connection through the shaft, are almost independent of each other. The lower one works with a large pressure-head and an extremely small suction-head; the reverse is the case with the upper one.

In winter, when there is a high head and a very low level of water in the tail-race, only the lower turbine is in operation, and, when wide open, it develops 1,200 horse power. In summer, with a small head and high water in the tail-race, both turbines are in operation, and, when fully opened, they deliver 400 horse power apiece. While doing this, they run at a constant speed of 80 revolutions per minute, and in order to preserve this steady speed they are constructed with the diameter of the guide wheels decreasing toward the top so that the whole turbine has a conical shape. The lower turbine also has a greater average diameter than the upper one, and both are divided into three rings, so that the large amount of water flowing through them will be exactly guided. The turbines are regulated by an automatic governor. This is, essentially, one with a hydraulic servomotor (or working motor), in which, however, oil is the working fluid. The adjustment is such that, while the regulating gates of both upper and lower turbines are controlled by a single centrifugal governor, yet when the upper wheel is closed, only the gates of the lower one are moved, and when both wheels are open, only the upper gates are operated. The transition from one method of operation to the other is effected automatically.

The ten newer turbines are multiple centrifugal wheels, and they were constructed with a view to increasing the speed as much as possible, 120 revolutions per minute being attained, and also to secure the best distribution of the water available at any time by corresponding variations of the cross section of the openings.

Moreover, these ten turbines are designed so that half of them will be used with the high heads of winter, the other half with the low summer heads. They also are regulated by oil-pressure governors.

The power derived from the turbines is transferred into electrical energy in the directly-coupled generators, and is used partly in the form of two-phase current for light and power and partly as continu-

ous current for operating an electro-chemical works. It may be mentioned that, according to the *Schweizerische Bauzeitung* for 1892, volume XX., page 62, the total cost of the finished plant was estimated at 6,000,000 francs, 3,000,000 francs of which were for the hydraulic part.

In the near future the city of Geneva will issue a complete official report on this undertaking, which is of very great technical and economic importance and highly interesting in every respect.

The station at Rheinfelden, shown in Figures 13 and 14, whose turbines were also built by Escher Wyss & Co., and which has already been treated in literature from many points of view, ranks with the one just described. With respect to the turbines, the plant is characterised by the division of each wheel into eight rings, which, in their form and in the way the water is led to them, correspond to the Francis design.

In this installation we also find two forms of construction, the

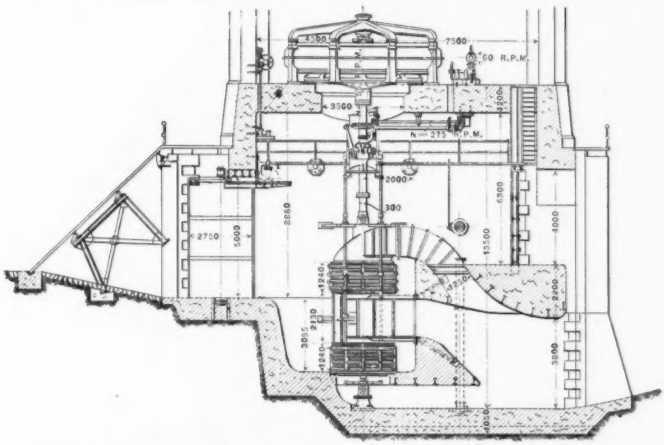


FIG. 13 SECTIONAL VIEW OF TURBINE ARRANGEMENT AT THE RHEINFELDEN POWER STATION

nine older wheels being designed for 55 revolutions per minute and the eleven newer ones for 68 revolutions. The regulation is effected through sluice rings worked by oil pumps of a similar construction to those at Chèvres. Each turbine develops 800 horse power with heads varying from 4.5 to 3.8 metres (14.8 to 12.5 feet).

These turbines indicate unmistakably the intense striving after a comprehensive adaptation to the requirements and needs of a com-

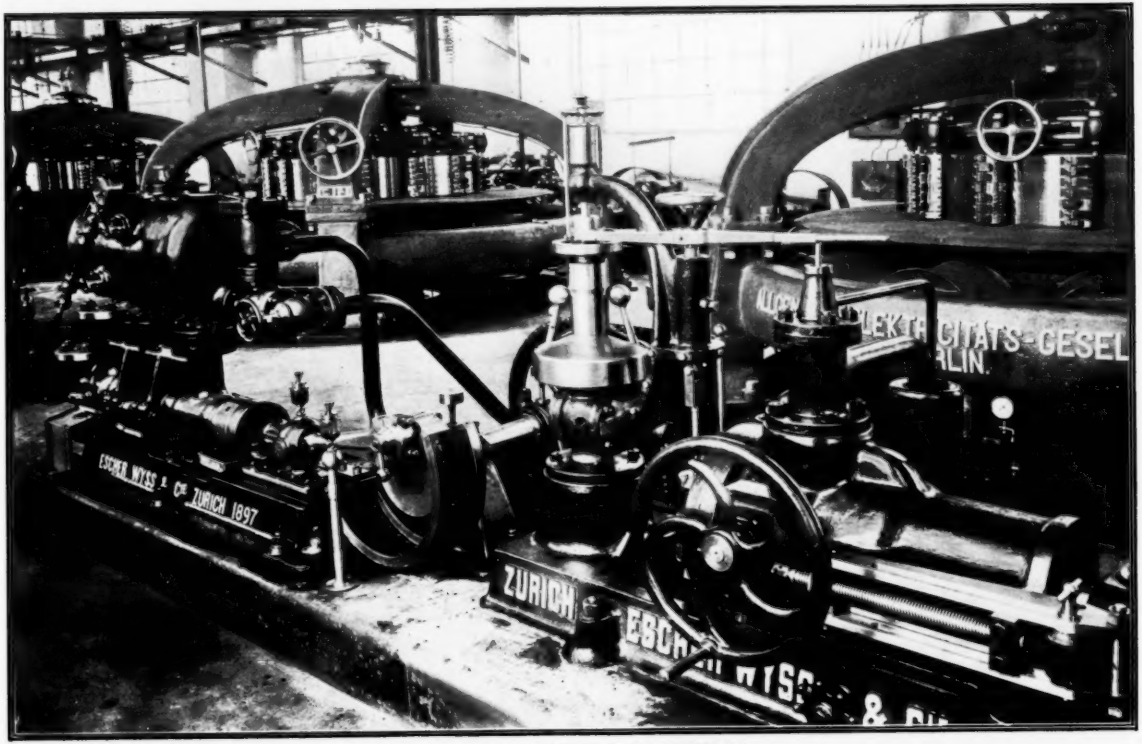


FIG. 14. POWER STATION AT RHEINFELDEN.

bined hydro-electric installation, and mark a decided step forward, which is a proof of the thorough technical knowledge, not only of the men to whose initiative the origin of these plants is due, but also of the engineers who were intrusted with the construction and erection.

It can be readily understood that with the many high falls of water which are available in the steep upper valleys of the Alps, the manufacture of the so-called, high-pressure turbines would also be well developed. The early designs of these wheels naturally resembled some of the well-tried forms: The partial-Girard turbine on a horizontal axis, the tangential wheel, the Pelton wheel, the spoon-shaped wheel, and all their different variations were used; and the builders have been principally employed in combining the regulating apparatus of the turbine itself with the automatic governor, in the construction of bearings with automatic lubrication and with shaping the form of the wheel in general.

In 1881, engineer Bosshard, of Zürich, first applied the hydraulic servomotor to a tangential wheel, the valve of the former being moved by an automatic governor, and brought this arrangement before the technical world at the Swiss Exposition, at Zürich, in 1883. In 1886 and 1887, Bosshard had already employed buckets with double-troughs. In 1885, Escher Wyss & Co. built the first high-pressure turbines with spoon-shaped buckets, and soon afterwards this same firm also employed the hydraulic servomotor, which was from the first supplied with all the details which experience and theory have shown to be necessary for the proper operation of a regulator. The Ateliers de Constructions Mécaniques in Vevey have built Pelton wheels since 1894. The remaining turbine manufacturers of Switzerland devoted themselves more particularly to the partial-Girard turbine.

The ever-increasing requirements for exact regulation now led to forms of construction, which, when shown at the Swiss Exposition in Geneva, in 1896, gave an excellent idea of the state of the Swiss turbine manufacture in that year. Among the typical instances of progress should be mentioned:

The compact arrangement of the high-pressure turbines and their regulators as a unit, the careful adjustment and lubrication of the bearings of the rapidly-moving shafts, the suitable application of water-deflectors behind the wheels, the comprehensive employment of spring governors, the careful construction of regulating valves of hydraulic servomotors, the application of mechanical servomotors to high-pressure turbines, and finally the automatic pressure regulator,

which was shown in various forms at the above named exposition by Escher Wyss and Bell. This last apparatus arose from the effort to prevent the water hammer which would take place in long pipes on the sudden closure of the regulating gates, and it consists essentially in an automatically actuated relief valve, which is placed in the pipe before the turbine.

Parallel with this briefly-sketched development of the high-pressure turbines proper, which receive their water from a guide apparatus with one or, at the most, two divisions, runs the evolution of the high-pressure turbine with guide-blades half-way or all-the-way around the circumference, which was constructed in compliance with the demand for single wheels with large capacities at heads of 50 to 100 metres (165 to 330 feet).

In the front rank of this class is the machinery in the hydro-electric station at Wädensweil, on the Sihl, built in 1893-1895, where Escher Wyss & Co. have installed five Girard turbines, each developing 400 horse power with a head of 65 metres (213 feet), net, and at a speed of 360 revolutions per minute.

The turbines are constructed with vertical axes for direct coupling to the generators, and work at their full capacity with water flowing in along half their circumference; the regulating sluice-gates are operated by an automatic governor, through a hydraulic servomotor.

Owing to the necessity for making the most economical use of the head of water, these turbines were provided with the Meunier apparatus, which was here employed for the first time in Switzerland. This apparatus regulates automatically the supply of air in the suction pipe below the wheel, so that the Girard turbine can run in air in the discharge pipe, independently of the varying level of the water in the tail-race.

The water-works connected with the installation are of great interest. They consist of a weir built in the Sihl, with sluice gate, gravel-way and spill-way; a conduit 2.2 kilometres (1.4 miles) long; a reservoir with a capacity of 250,000 cubic metres (8,800,000 cubic feet), which is formed by the side of a hill and by a tamped earth dam 107 metres (350 feet) long, 15 metres (50 feet) high and 63.5 metres (208 feet) thick at the base, and a steel-plate pipe 1.5 metres (5 feet) in diameter and 705 metres (2,313 feet) long, which, at a suitable place, has an air pipe to prevent hydraulic shocks.

Other plants of this class are: The hydro-electric station of La Goule, also constructed by Escher Wyss; the plant for the Jungfrau railway at Lauterbrunnen, built by Rieter & Co.; the new installation

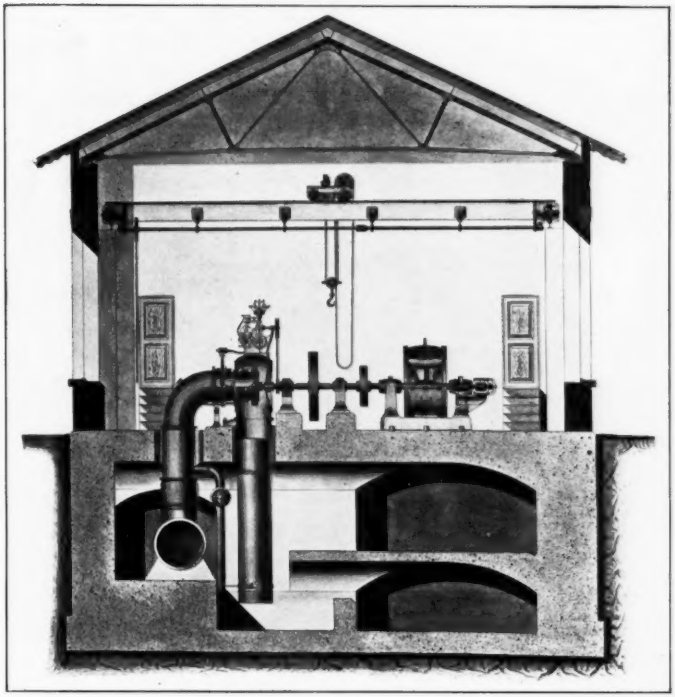


FIG 15. ELECTRO-HYDRAULIC STATION, LES CLÉES-YVERDON. GENERAL SECTIONAL VIEW

at Dornberg, near Luzern, made by Bell, and many other undertakings, each of which in its design or arrangement shews progress of some material nature.

There might still be mentioned a number of improvements in hydraulic machinery, which are solutions of the problems set by modern conditions of operation, such, for instance, as the mechanical governors of Piccard & Pictet, whose remarkable efficiency secured to that firm the order for the first 5,000-horse-power turbine at Niagara, and one form of which is shewn in Figure 15, a section through one of the machines at the hydro-electric station of Les Clées-Yverdon. But these various constructions will not be further dwelt upon here, particularly as their adequate description would call for many detailed drawings, and only that phenomenon will be emphasised, which has been of the most far-reaching importance in the latest de-

velopment of Swiss turbine manufacture, namely, the application of the modern Francis turbine, which was begun in 1894.

It is true that in the years 1855 and 1857, and later, the firms of Rieter and Escher Wyss built Francis turbines, owing, doubtless to the influence of Francis's celebrated work, "The Lowell Hydraulic Experiments," but, as may be proved by statistics, the number of the wheels built on this system was extremely small up to a very recent

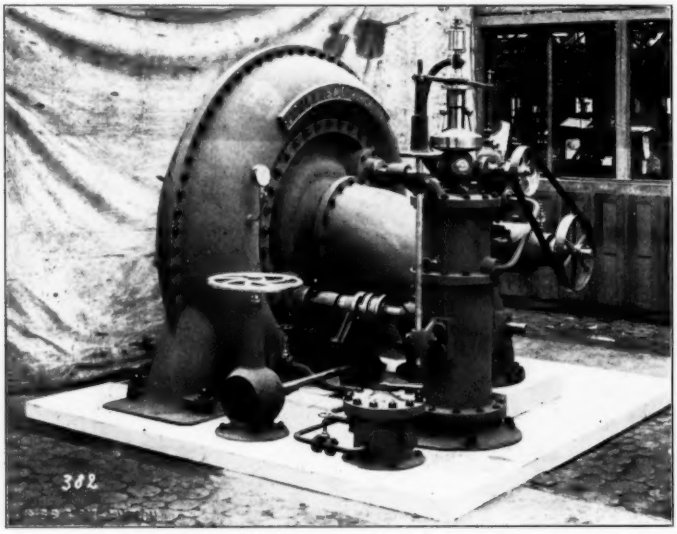


FIG. 16. ENCLOSED FRANCIS TURBINE WITH GOVERNOR.

Escher Wyss & Co., Zürich.

date, and they all lacked the characteristic mark of the modern Francis turbine, namely, the simultaneous movability of the guide-blades, which was proposed by Prof. Fink, of Berlin, in 1864-1866, and afterwards systematically developed by the firm of Voit, in Heidenheim, Würtemberg.

As may be established by simple calculation, the Francis design of wheel, other things being equal, requires the smallest dimensions, and also makes it possible to place a number of rings, one above another, so that a large flow of water is secured with a small diameter of wheel. When it was recognised what great advantages this turbine possessed where large capacity was to be combined with high speed, it was rapidly introduced. And as the knowledge concerning this wheel

grows, through theoretical investigations and practical experience, it is seen that besides having a most favourable flow in the admission and discharge passages, the water chamber and the suction pipe, the Francis design secures that constant filling of all the turbine spaces with live water, even when the cross-sections are diminished, which is essential to high efficiency. This knowledge has led to the general adoption of the system.

Since 1896, the manufacture of the modern Francis turbine has been taken up by nearly all the Swiss companies, and the victorious course of this system will be sufficiently indicated by a few statistics. Up to the year 1896 the old-style Francis turbines built in Switzerland had a total capacity of only 600 horse-power, while from 1896 to November of 1899, the number of new-fashioned Francis turbines, finished and under way, reached 210, with a capacity of 80,000 horse power. The system is used in all the more important new installations, with variations, it is true, depending upon the individual ideas of the constructors of the different companies.

With a keen appreciation of the adaptability of the system to the most widely differing circumstances, machines have been constructed which, with regard to economy in utilising the available energy, have reached the limits of possibility. As a case in point may be cited the 200-horse-power turbines which Escher Wyss have installed in the paper factory on the Sihl, whose efficiency, within wide limits of admission, reached the high figure of 86 per cent., according to thorough and careful tests made by me.

An example of such construction is shewn on the opposite page, Figure 16, as well as in the reports which treat of the turbines at the Paris Exposition, where this latest period of development was illustated in a striking manner.

It might almost appear that with such progress the problems of turbine engineering had been solved; this is, in fact, partly the case, and when, in the not far distant future, the great projects of Switzerland, which have for their objects the utilisation of about 120,000 horse power, shall be realised, they will be founded on the knowledge and experience gained up to the present day.

Nevertheless, it is probably true that the economic conversion of such great quantities of energy will lead to new problems, which today we anticipate as little as, but a short time ago, we understood the difficulties which, for instance, are connected with the operation of hydraulic motors when they serve as transformers of energy for electro-chemical works or standard electric railways.

CAPTAIN JOHN ERICSSON.

From an oil painting in the possession of the American Society of Mechanical Engineers, by whose courteous permission it is reproduced here. The painting was found in the shop of a dealer in second-hand goods, in Brooklyn, and purchased by the finder for the Society. A newspaper paragraph led to its identification by the artist, who happened to be passing through New York on his way home to Norway, as his own work, painted years before at the instance of a committee of Ericsson's admirers for presentation to the inventor himself. The intervening history of the painting is not known.

PERSONAL RECOLLECTIONS OF CAPTAIN JOHN ERICSSON.

By Egbert P. Watson

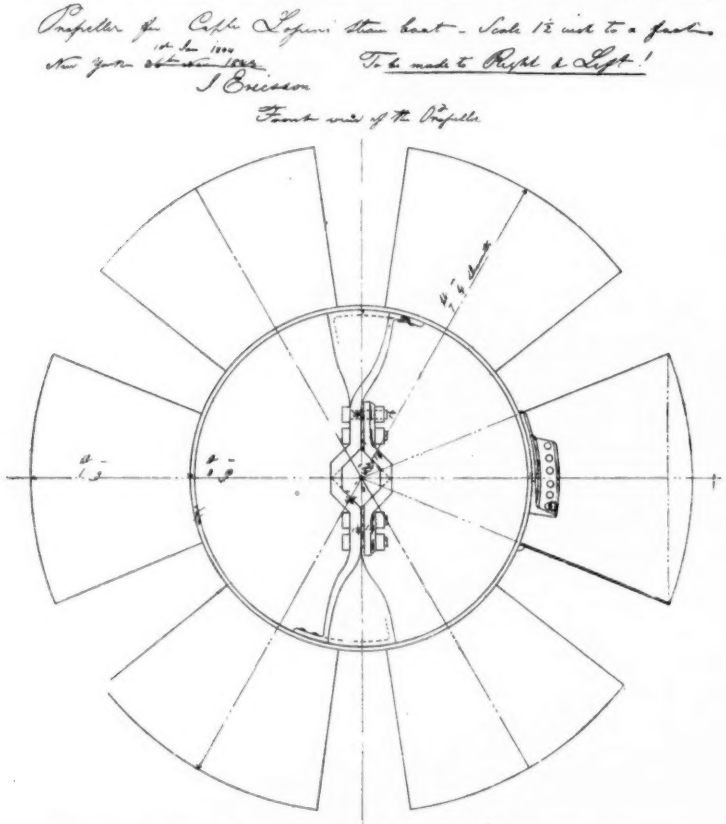
The interest of personal memoirs of men who have strongly influenced the thought and progress of the world needs no argument. The reception given the biographical studies of Lord Armstrong, the Krupp family, Andrew Carnegie, and George Westinghouse, in our Works Management Number last January, proves how strikingly the man of action appeals to the modern world of action.

The accompanying sketch is of a somewhat different character, but is valuable in throwing a new light on the character and habits of thought of one of the most picturesque figures in a period of remarkable engineering change and progress.—THE EDITORS.

ONE of the most notable figures in the engineering world of the last century was Captain John Ericsson, best known to fame as the practical inventor and adapter of the Monitor type of war-vessel; for while he was not the first to propose a rotating floating armored gun-carriage on ship-board, he was certainly the first to put such a vessel under fire against an adversary. That claim has never been disputed successfully, and upon it some are disposed to rest his chief claim to the recognition of posterity, for it has to a great extent revolutionized naval warfare. Be this as it may, the man himself was scarcely less remarkable than his several inventions, not merely by his advanced views in matters appertaining to his profession, but in his personal characteristics, bearing, carriage, and general walk and conversation. He would have been notable any where and in any age for these differences from the average man. Even his personal appearance was striking. He was of medium height, very florid complexion, rather darker in tone than Europeans generally, with bushy black side whiskers. His address was abrupt, dictatorial, even domineering at times, and no one cared to enter into an argument of any length, or to advance opposing views, for that matter, after one experience. Captain Ericsson was of a robust figure, rotund in person and in voice, with an address which left no doubt whatever as to the meaning of his utterances. It cannot be said that he was an agreeable man to do business with; although he did not intentionally violate any of the canons of good breeding or good feeling, he was too much in earnest and too anxious to conclude whatever was under discussion to pay much attention to graces of delivery.

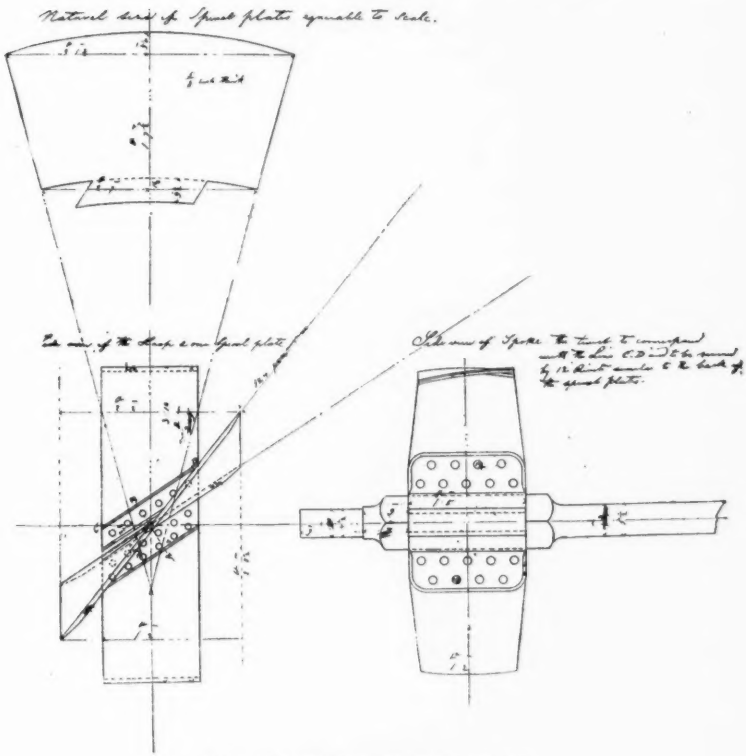
He could unbend and be genial upon occasion, but it was like a

gleam of sunshine from a March sky and did not last long. With all these blemishes he was an extremely liberal man from a pecuniary


Propeller for Capt. Ericsson's Steam Boat - Scale 1½ inch to a foot
To be made to Right & Light!
J Ericsson
Front view of the Propeller

REPRODUCTION, ABOUT ⅓ SIZE, OF AN ORIGINAL DRAWING OF CAPTAIN ERICSSON'S, DATE 1844.
Note the use of wrought and forged work, adapted to the possibilities of that time.

point of view, but he insisted upon the absolute letter of a contract or a specification, and woe unto him who endeavored to evade one, unsanctioned by him! So insistent was he upon this point that in at least one instance a ludicrous thing took place. It was customary in those days to get the length of a piston rod the last thing, after the other details were in place. In pursuit of this object a draughtsman once went down into a cylinder with a long baton, and had hardly got



CAPTAIN ERICSSON'S SCREW PROPELLER.

Projection of the front view shown on the opposite page.

off of the ladder which led down into it when Captain Ericsson came on deck. Espying the draughtsman he said:

"What are you doing in my cylinder, Mr. Nelson?"

"I am getting the length of the piston-rod, Captain Ericsson."

"Have you looked on the drawing, Mr. Nelson?"

"No, sir."

"Come right out of that cylinder, Mr. Nelson, I will not have people going down in my cylinders with sticks for measures; go and look on the drawing, sir, and you will find the length of the piston-rod." This point he always insisted upon—that his drawings were correct, and if they were followed no loss would ensue. A workman once told me that he had a connecting-rod for a link motion to put up in which

there were as many offsets as there are in a dog's leg, and that, try as he might, he could not get the rod in. He told Captain Ericsson of this and was asked if the rod was right according to the drawing; the man said that it was. "Then it will go in," was the reply, and after another trial it did go in.

For most of his devices he had models made to scale, showing the relative positions of the parts with accuracy; they were finely finished and put together, and drawings were made for them exactly as they were to be constructed; woe unto the model maker if he did not make every detail according to the drawing. If a fillet was omitted, or square-head bolts put in where hexagon-heads were indicated, the departure had to be rectified, no matter what it cost the model maker.

Captain Ericsson had his friends and his foes, as all mankind have; the former—when loyal—he rewarded richly, but for the latter, he simply defied them for all time. "I do not care what you do, sir," he said in my presence to one who opposed him; "I live for the truth, sir, and I will have what is right or nothing!" and he struck his fist down on a heavy rosewood table with such force that a large cut-glass inkstand jumped about six inches.

It was through a singular train of circumstances that I first came in personal contact with Captain Ericsson, and enjoyed his personal acquaintance. When the American civil war broke out I was employed in the Novelty Iron Works, where the original Monitor was fitted with its turret. This, as is well known now, consisted of a series of plates bolted together by through bolts, one-inch diameter; being detailed to make a reamer to true the holes, I did so and tried one bolt to see if it fitted properly, thus driving the first bolt in the turret. Shortly after I was employed upon the *Scientific American* as associate editor, and being thoroughly familiar with the Monitor construction, defended her plans and principles from all and sundry who attacked them, and in those days there were plenty of assailants. After possibly six months of this warfare, I received notice that Captain Ericsson desired to see me and it was with no little trepidation that I set out to keep the appointment. Captain Ericsson lived and died at No. 36 Beach street, New York, a part of the city, just out of West Broadway, that had once been of great pretensions, but had then fallen very much in public esteem. The surroundings were poverty-stricken, and even squalid in appearance. The basements of the still handsome houses were tenanted by green grocers, rag and bone "merchants," junk-men, and charcoal peddlers. The windows were tenanted by frowsy cats dozing in the sun, while through the wide-

open hall doors troops of shouting boys raced incessantly. I had some doubt as to the correctness of the address given, but kept on until it was reached and found it. Scarcely had I delivered my card and been ushered in to the front parlor when a noise was heard as of a ton of coal being violently thrown down stairs and Captain Ericsson rushed in holding out both hands. He said, in a voice like one hailing the main-top in a living gale: "You are Mr. W.! I am very glad to see you, sir; you have done me a great service, sir; Wait here, sir, I am very busy indeed!" and away he sped out of the room with the agility of a youth of twenty. Back he came in a very short time with a long yellow envelope which he thrust into my hand, saying, "Take that with my compliments, sir; I am very busy. Good morning, sir!" and ushered me out without further ceremony.

The whole interview was, as one may say, extremely abrupt, my part in its being confined to saying "Yes, sir" and nothing more. Safe outside of the door, I carelessly tore open the envelope, thinking it had papers referring to the Monitor, when, to my consternation, five $50 Treasury notes slid out on to the sidewalk. Being convinced that a mistake had been made, that in the haste of the moment the Captain had picked up the wrong envelope, I lost no time in ringing the bell again, with a request to see Captain Ericsson. He came down as before, in a moment, greatly perturbed in manner and speech.

"What is the matter now, sir?" he demanded. "Why have you called me down again?"

"Captain Ericsson, there is money in this letter, I thought it possible that you might have made a mistake!"

"No, sir; there is no mistake, I do not make mistakes; nobody shall do me a service but what (sic) I shall pay him; Good morning, sir!" and he promptly thrust me out upon the door step again. Lost in speculation as to what manner of man it was that did business in so brusque and abrupt a fashion, I went back to my avocations and reported that Captain Ericsson had made me a present, omitting any details as to the amount of it. I was told to pocket all such insults, as mere business details. A repetition of the same affront from Captain Ericsson some weeks later did not seem to require a report.

This incident may seem trivial to the reader, but it is so characteristic of the man and his methods that it is worth recording. He could, however, use far different methods with those who sought to get money from him by disreputable means. No one was shrewder than Captain Ericsson to detect at once any attempt to swindle him. At a subsequent interview, also connected with the Monitor, Captain

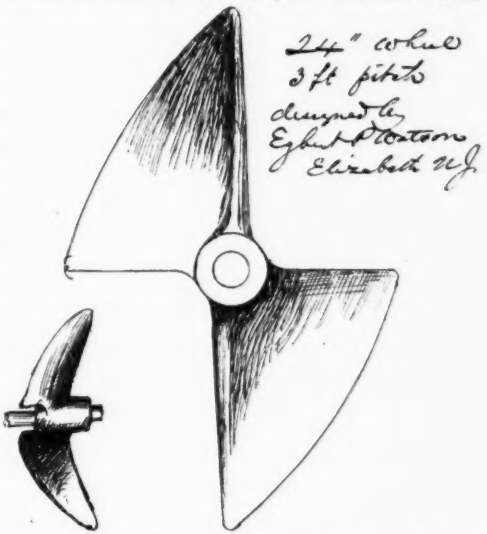
Ericsson came into the room in the stormiest of humors. "Where you sit now, sir," he said, "a damn rascal tried to make me pay hush money; he said he was the son of a clergyman, was a reporter upon the New York ——, and knowing that a leader was about to be published unfavorable to the Monitors, he thought it best to show me a proof; his principles would not allow him to take what he considered an unfair advantage of his position. Do you know what I said to that infernal scoundrel, sir?" (towering over me like an incarnate spirit of wrath) " 'Suppose I do not wish to have it published,' I said, 'what then?' 'In that case it will cost $1,000 to suppress it,' the fellow told me. 'Go and publish it at once, sir. I do not care what lies you publish; it will be all lies; you know nothing about my vessel, sir. I live for the truth, but you have no truth. Get out of my house at once, sir! I will not have such a rascal as you are in my presence!' " There is no doubt but that the order was obeyed.

Captain Ericsson was not a vain man, in the ordinary sense of the word, and gross flattery or fulsome adulation was as irksome to him as it is every man with common sense; but he knew the value of his professional work, and anyone who was capable of appreciating it was his friend. He was quick to see the value of the discoveries of others also; provided they were orthodox in construction and in intention he supported them, but he had little mercy upon those who were mere revampers of the ideas of others.

He was years ahead of his time in engineering, and was always a student along all lines of it; especially did he delight in new mechanical movements and combinations, and his adaptation of them to the end sought was always striking, though possibly not always elegant. John Ericsson was among the first to see the advantages of the screw as a propeller of vessels, and the history of the introduction of it and the first experiments with it are examples of his faith in it. This last strengthened as he grew older, and the "Delamater screw," so long used in days now past, was designed by Captain Ericsson, though built at the works above named.

Like many others, I once conceived that I had devised a new idea in screw propellers, and to test it built a small working model of a launch. This model was 48 inches long by 6 inches beam, and had about 10 pounds displacement. It had an engine and boiler which weighed 5 pounds, and the boiler, or boilers, were only 2 inches diameter by 12 inches long, so any desired pressure could be carried on it. Upon trial the conception worked very well indeed, and, full of the idea of a speedy fortune, I was emboldened to ask Captain Ericsson's

opinion of its commercial value. It was not easy, or agreeable either, to undertake this, for Ericsson was at all times beset by inventors to view their plans, and also to endorse them; he said that if he consented in one instance he would have to in others, and his time would be so taken up that he could not do anything else. Nevertheless he did consent, in my favor, and by appointment the model was taken to Captain Ericsson. He looked at it carefully all over for some time without remark, but finally said: "What are you trying to do, sir? Do you know what you are trying to do? Look at this" (striding rapidly across the room and laying his hand on one of the large mahogany doors) "a screw with no more area than this will drive a ship of 3,000 tons all day and forever, if you keep it going; how can you beat that? Do you think you can beat that? No, sir; you cannot beat it; your screw is not worth a damn sir; I don't care what shape you make the blades, you cannot beat a true screw."



SKETCH OF FISH TAIL SCREW REFERRED TO BY MR. WATSON; DATE ABOUT 1875.

"This is a true screw, Captain Ericsson," I ventured to observe.

"Oh! is it; I thought from the appearance of it it was some kind of a mongrel pitch!"

"No sir: the shape of the blades is governed by the principle of the wheel, and is merely incidental."

"All that is nonsense, sir; I do not care what shape the blades may be so long as you have a true screw as regards the pitch. If it is, as you say, a true helix, you have just as much but no more than the present screw, in which event you have nothing more than exists now."

There was no appeal from this verdict, and as I had invited criti-

cism, and obtained it, I had to be content with it. Captain Ericsson then inspected the model more closely and inquired what speed had been obtained from it, and when told that it was three miles an hour by the watch for a short distance, said, "My! you have done a great thing, sir; I never could get half that speed with a model."

"Perhaps not, sir, with clock work, but this engine has worked under 200 pounds per square inch, and makes at least 2,000 revolutions per minute."

"How do you get any such pressure as that?" said Captain Ericsson.

"With oil fuel and by 'bottling her up,' as it is called."

"Oh, ah! that is possible then," and there the subject was closed.

It has been said elsewhere in this article that Captain Ericsson was ahead of his time in engineering investigation and practice; this is true as regards the comparatively recent advance from low boiler pressures and few expansions to high boiler pressures and many expansions. In the later years of life he gave this matter more attention than he had in earlier years. There are fashions, as one may say, in all directions, and high expansion was, and is for the matter of that, the question of the day.

Captain Ericsson was not a believer in the necessity of multi-cylinder engines to obtain economical high expansion, declaring in so many words that they were only devices of English engineers to make more work. He asserted that higher economy and better results all round could be had in two cylinders than in triple or quadruple cylinders, and he designed a two-cylinder high-expansion engine to embody his views, and to prove or disprove them. It was, in appearance, an ordinary tandem-compound horizontal engine, but it had a much higher ratio of cylinders than any engine built prior to it had. The high-pressure cylinder was 8 inches diameter, the low pressure 32 inches diameter, by 24 inches piston stroke; a nominal number of expansions would be, reckoning from initial to terminal pressures, twenty-four, but I was informed that the actual expansions shown by indicator cards was nearly thirty-six. The usual number of expansions for an engine of the size named would have been eight. The boiler pressure was 200 pounds per square inch. With a consideration which was highly appreciated by me as a personal compliment, Captain Ericsson sent a special messenger to say that he desired me to be the first one to see the engine in action in the Delamater works, where it was built—after the constructors, of course—and I took immediate advantage of the opportunity. The valve-gear, outside of

the extraordinary cylinder ratios, was the most remarkable feature. It had a gridiron slide-valve operated by a sword arm on the main shaft so quickly that the exact point of cut-off must have been difficult to ascertain; it literally snapped the full boiler pressure onto the piston as a bullet is fired from a gun. It has been asserted repeatedly that this method of induction could not be used practically, owing to the great shock on the details, but this engine worked as quietly and as smoothly as any engine with a common valve-gear. It continued so to work for several months. For duty it drove a screw propeller in an enclosed tank, and showed a higher economy than any engine within my knowledge had shown up to that date—about 1884-86. The tabulated results, as shown by carefully worked-up indicator cards, gave under twelve pounds water per horse power per hour, as against eighteen to twenty pounds for ordinary two-cylinder compound engines, and fourteen to sixteen for triple and quadruple-cylinder engines. Its mechanical action left nothing to be desired. This engine is still in existence, or was a short time ago, in custody of the trustees of Captain Ericsson's estate; an attempt was made shortly after his death to put it on the market but it came to nothing.

Captain Ericsson was a most indefatigable worker all his life; it may be said of him literally that he dropped his pencil only to die. After he was 83 years of age he sent his secretary to me with a pencilled drawing to show that his cunning had not departed from him. When his physician had at last made it clear to him that his work was done (at nearly 84 years) he was unreconciled, and his last words were in connection with his work: "Have I got to die?"

Captain Ericsson made a great deal of money in his profession, but he also spent a great deal in many directions, and at the close of his career had little or nothing to show for it except his record. His bequests to those who had served him in any capacity for years —members of his household and professional assistants—were munificent, but when the trustees came to realize upon the assets they shrunk to insignificance. For years Captain Ericsson had a large income from his hot-air pumping engine, but for the Monitor type of armored vessels he never received a penny from the United States.

This brief transcript of my acquaintance with Captain Ericsson is in no sense a memoir, but embodies only the salient points of my knowledge of one who was, in all senses of the word, a most remarkable man. As much has been omitted as has been set forth, but what has been given will perhaps show a different side of Captain Ericsson from the generally accepted idea of him.

ACTUAL EFFICIENCY IN STEAM GENERATION.

By A. Bement.

In every branch of productive activity, empiricism is giving way to methods based on exact knowledge. Mr. Bement shows how, in the initial operation of power development—the realization of the latent energy in the fuel—engineering and chemistry may work together in perfecting practice.—The Editors.

SPECULATION concerning the heat efficiency of steam boilers and furnaces is active enough, but there is a confusion of ideas and opinions leading to no logical explanation of the matter. This is largely owing to the fact that the chemical process in the furnace and its relation to and effect upon the efficiency of the steam-generating apparatus have not been taken into consideration. The mechanical engineer controlling the design and operation of furnaces and boilers, not being a chemist as a general rule, has relied upon the data furnished by physical evidence for an explanation of the phenomena, while the chemist on the other hand, from lack of experience and knowledge of the physical conditions, is at a decided disadvantage. An understanding of the chemical features of the problem is essential to its examination, and in addition thereto, the proper method of manipulation in operation must be studied from this standpoint if good results are secured.

One of the conditions having an influence on efficiency has more or less generally been supposed to be the number of pounds of coal burned per square foot of grate per hour. It has been contended by some that the combustion of a small number of pounds was conducive to better results than if a larger number were burned. Tabulated results and data from experiments have been offered, showing that as the pounds of coal burned per square foot increased, the evaporation per pound of coal decreased; but, on the other hand, data have been submitted showing the opposite result, and very often in boiler trials it has been found that the most water was evaporated per pounds of coal when the horse power developed was much in excess of the rated power. The amount of coal burned in a given time has an important bearing on the performance, but the amount burned per square foot has no significance, because there is no standard grate

area. The ratio to that of heating surface may, and does, vary from 1 to 30 to 1 to 90 in different cases and varying kinds of service, and if the number of pounds of coal burned per hour per square foot of grate is to be taken as affording any evidence of effect on efficiency, it could apply only where other conditions were the same—as, for example, in different experiments with the same grate and heating surface. The better way would be to state the total pounds of coal burned in the hour. This leads to the effect on efficiency of the temperature and quantity of the gas which may pass from the furnace, and also of complete or incomplete combustion.

The work of the furnace is to oxidize carbon to CO_2 and hydrogen to H_2O. These gases and the nitrogen, together with the unused air present, serve in a measure as the carrier of the heat generated, and it is desirable not only that the combustion shall be complete, but that the volume of the gases be as small as possible, because their temperature will be governed by their volume. If the volume is large, the same amount of heat, distributed throughout the larger mass, will produce a lower temperature; further, the amount of heat carried away by the gases will depend on the volume of these gases escaping from the boiler. For these reasons the temperature of escaping gases has no significance whatever, unless their quantity is known—just as, with a quantity of water, the heat contained would not be shown by the temperature alone; the number of pounds must also be known.

The initial temperature of the gases at the furnace is important because the transfer of their heat to the boiler will be governed by the difference between their temperature and that of the boiler. Therefore, as the quantity of gases is smaller, the furnace temperature will be higher, the heat transfer to the water will be greater, and as a result, the gas will pass from the boiler at a lower temperature. The efficiency will be greater because there will be less actual heat units in the escaping gas. The volume of the escaping gases is probably neglected more than any other feature of the problem, but when it is realized that under most favorable conditions the air supply in weight cannot be less than twelve to fifteen times that of the coal, and may and often does actually exceed fifty or sixty times, the effect of the quantity of air is seen to be of supreme importance.

If some of the conditions of operation are examined, many of these features will be illustrated. To this end it may be assumed that the completeness of combustion bears a constant relation to the air supply; the volume and weight of gas would then be in constant ratio to the weight of combustible. Under these conditions, as the

amount of coal burned *in a given time* is increased, the temperature of the escaping gases rises and the efficiency falls, regardless of the rate of combustion per *square foot of grate*. This condition is best defined by saying that, other things being the same, as the quantity of coal burned in a given time increases, the efficiency decreases, or as the coal decreases, the efficiency increases, because a given amount of heating surface will better cool the smaller amount of gas evolved.

With the same amount of coal burned to complete combustion, the efficiency will decrease as the air supply increases; this is because the volume of gases increases, and not only their volume, but their final temperature will increase; this latter condition is caused by a lower furnace temperature, which, together with the greater volume, presents a cooling problem of greater difficulty for the boiler.

With constant amount of fuel burned to complete combustion, and with very large air supply, the efficiency will be correspondingly low; as the air supply is reduced the efficiency will rise to a maximum, which will be reached at minimum air supply for complete combustion.

Starting with an excessive and uniform air supply, the efficiency will increase as the amount of fuel burned increases, and the relative volume of gas per unit of fuel will decrease. While the relatively smaller volume of gas in the first instance yields lower temperature of escaping gases, the increasing amount of fuel burned causes an increase in temperature, and the greater efficiency is due to a much reduced proportional volume of gases.

With a condition approaching incomplete combustion, and an increase in the fuel supply or a reduction of the air supply, the efficiency of the steam-generating plant as a whole will be less; the temperature of escaping gases will be lower. Under these conditions, the resultants are higher initial temperature, smaller volume of gases, and lower final temperature; but with these conditions the efficiency of the boiler proper increases, because the work of the boiler is to absorb the sensible heat of the gases, and therefore, as the furnace efficiency drops rapidly on account of incomplete combustion, the boiler efficiency rises slightly. It thus appears that the final temperatures are of no significance, unless considered in connection with the conditions of combustion, or the relative constituents of the gas.

Circulation of the water in the boiler is frequently credited with a very large and important effect on efficiency, cases having occurred where large incomplete-combustion losses have been charged to this cause. There is no doubt that circulation has some influence on heat transfer, just as has an unclean boiler, but these influences are cer-

tainly over rated; because if there is a large amount of the heat of the coal not accounted for in the steam, in sensible heat in the gases, radiation, etc., it must either exist as latent heat in the gases from incomplete combustion, or be stored in the metal of the boiler. If the latter is the case, it would not take very long to heat the boiler to a temperature that would insure its destruction. A case coming under my observation is of interest in this connection; it was that of a forced-draft furnace where the requirements were for a good efficiency at rated power of the boiler, and ability to attain a maximum of double the rating. On a trial at rated power the performance in pounds of water evaporated per pound of coal was quite satisfactory, but with the effort to attain large power, although all the coal was fed to the furnace that it would take, the horse power was about 3 per cent. less than on the first experiment. The excess amount of coal used in the second experiment was more than sufficient to melt the entire boiler and to heat all of the brick work red-hot. This boiler had previously been worked at a rate of a horse power for each five square feet of heating surface with perfect ease, but with another furnace. In this case the trouble was that the limit of the air supply had been reached, at rated power; and this illustrates one of the features that gives mechanical draft an advantage, which is, that it is not what it is usually considered to be, a scheme for large air supply, but is, in fact, the opposite, and for this reason suits usual prevailing conditions of stationary-boiler practice where the tendency is for too-large air supply.

The diagram, Figure 1, shows losses in hot gases with varying air supplies and complete combustion. It is apparent that with a very good condition as illustrated by 15 per cent. CO_2 the loss is about 2½ per cent. for each 100 degrees F. rise in temperature; with 8 per cent. CO_2, 5 per cent.; and with 4 per cent. CO_2, about 10 per cent. If it is assumed that an economizer would reduce the temperature of gases 200 degrees, then its application under conditions with 15 per cent. CO_2 would result in a saving of 5 per cent.; of 10 per cent. with 8 per cent. CO_2; and of 20 per cent. with 4 per cent. CO_2. The best opportunity afforded the economizer is with such condition as illustrated by 6 to 8 per cent. CO_2, because with the poorer conditions the efficiency of the combination would be so low as to be unsatisfactory whatever the performance of the economizer might be.

The engineer or the expert, may, after trial, certify to the evaporation of a certain number of pounds of water per pound of coal, or to a certain percentage of efficiency which may be entirely satisfac-

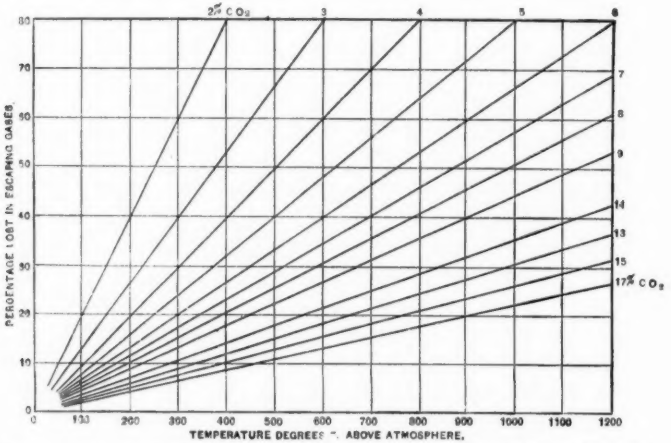


FIG. 1. LOSS OF HEAT WITH COMPLETE COMBUSTION AND VARYING AIR SUPPLY.

tory; but a steam-generating apparatus is expected to perform service for several years, and its efficiency during this time is of vital importance, and if it is a fact that in everyday performance the trial results are repeated, then the owner is assured that economy in coal consumption is obtained. I should gather the impression that the opinion is quite general among owners, especially in the United States, that because the performance on trial was good, or because they had purchased standard apparatus, they were getting economical results in everyday work. As an almost universal fact, however, nothing could be further from the truth.

There are two conditions which must be complied with, or economical performance will be impossible; the first is complete combustion, and the second minimum air supply; and these conditions must not only occasionally be secured, but must be maintained as regular practice. That these are conditions that are *not* generally complied with, cannot be stated with too great emphasis, as evaporations of from one to four pounds of water per pound of coal are actual performances in a good many cases, and everyday efficiencies of from 25 to 50 per cent. are rather the rule than the exception.

There are several things that conspire to keep the owner in ignorance regarding these facts. One is, that published records of trials lead him to assume that, because the efficiency of a steam-generating apparatus is given as 70 to 85 per cent., this performance is necessarily an inherent characteristic of the apparatus. Nearly all

trials of importance are made to show fulfillment of guarantees, and often, if the results are not satisfactory, other experiments are made, or a more skillful expert is called in, who understands how to harmonize the matter of complete combustion with minimum air supply and low temperature of escaping gases, with resultant exhibition of a high efficiency. It would be of great value if the results of preliminary trials were fully reported; likewise, if experiments were made to ascertain how low an efficiency could be secured, such data would be of more value than many of the trials for high results.

In one way the furnace maker is to be blamed, because he does not impress on the purchaser the importance of careful and intelligent manipulation, and the realization of the fact that satisfactory performance can be secured in no other way. In my acquaintance there is only one furnace maker who gives this feature due prominence. It must be said on the other hand, however, that the purchaser is usually looking for something that requires no skill to operate, and which promises to go right of itself, and if a furnace maker emphasizes the importance of skillful working, he is in danger of losing a customer to some other maker who is willing to cater to the purchaser's ideas.

Often an engineer will weigh the coal and measure the water evaporated, with the object of ascertaining the economic performance of his plant; but the method pursued is calculated to defeat the object, because he is likely to detail his best firemen for the work, and the man will himself endeavor to do as well as he knows how, either for his own credit or because he is imbued with the idea that an experiment of this character required much greater care on his part than is necessary in everyday work. The result is a performance which is very much better than the average.

It is, indeed, a difficult matter to ascertain how bad a performance may be, because as soon as the fireman sees that he is being watched he is sure to improve his practice, and any preparation toward weighing coal or measuring water is at once an incentive for him to do his best. The method best suited to secure evidence of every day conditions is testing the products of combustion, and if provision is made so that this may be done when the fireman is not aware, some surprising conditions may be discovered.

Illustrating this point, Figure 2 will be of interest. It shows the percentage of carbon dioxide, plotted from indications of an econometer at the time some experimental work was under way, while the man supposed that gas was being taken from some other boiler; upon

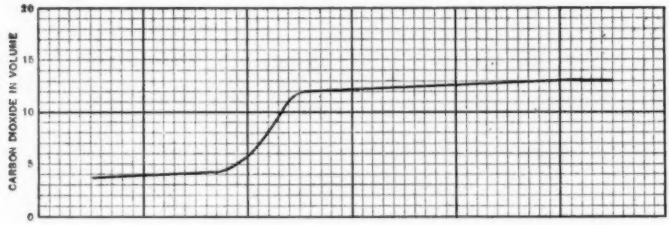


FIG. 2. RISE IN EFFICIENCY OF FIRING UNDER THE SPUR OF OBSERVATION.

his discovery that his work was being observed, the character of combustion changed as shown by the rise in the curve, from 4 to 13 per cent. CO_2, with a reduction of loss of about 32 per cent. In this connection Figure 3 shows the prevailing CO_2 for one hour in another case.

Where there are a number of boilers of uniform size each fitted with a furnace of the same capacity, the impresion likely to be given is that there would be a similarity in the amount of work from each. Figure 4 shows samples of performance of this kind. The curves A, B, and C, show various average amounts of water evaporated per man and per boiler for three different days; the record A being first taken, it is plotted in the order of decreasing pounds: the two other curves are governed in their formation by the order of men as arranged in A. It will be observed that while some of the points of the three curves show an approximate agreement in pounds of water, others are widely different. There is a difference between the highest and lowest horse power of 46 per cent., and in efficiency the difference was not less than 30 per cent. It should be stated that the performances shown by Figures 2, 3 and 4 are not selected from sources where the conditions and practice would be expected to be bad, but from plants in which results much above the average are secured.

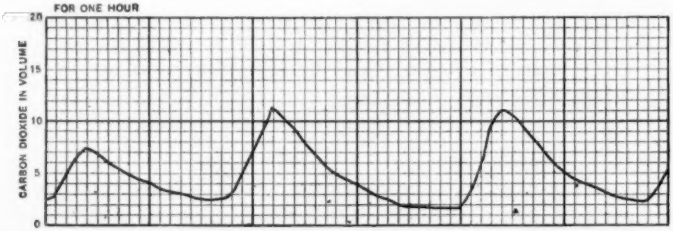


FIG. 3. PREVAILING CO_2 IN AN HOUR'S FIRING.

Very large savings can be effected by improved management and methods of operation, and this will be best secured through study of conditions of combustion. Loss by bad conditions is quite often attributed to what is designated as incomplete combustion, and incom-

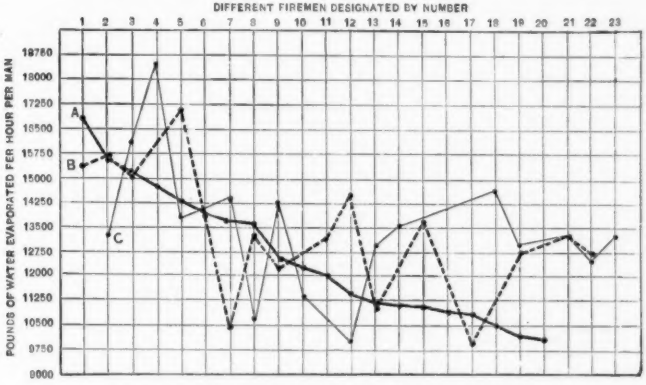


FIG. 4. EFFICIENCY RECORDS OF VARIOUS FIREMEN.

plete combustion, as far as carbon is concerned, is its oxidation to carbon monoxide. Diagrams 5, 6 and 7 will explain this feature, as well as the effect of volume and temperature. These diagrams, for simplicity of illustration, are based on the assumption that the fuel is

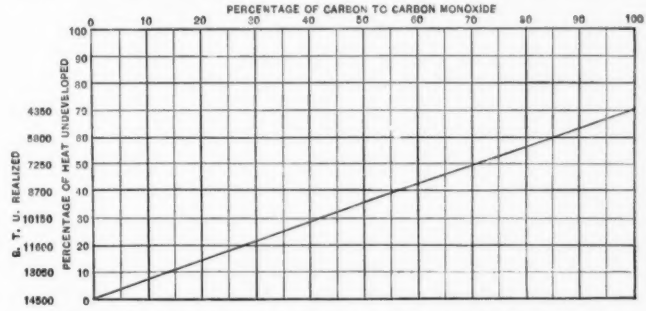


FIG. 5. LOSS OF HEAT WITH CARBON CONSUMED TO CARBON MONOXIDE.

carbon, and the conditions are carried to the theoretical; for example, complete combustion with no excess of air with all of the carbon accounted for in CO_2, and also all of the carbon accounted for in CO, with no air present.

Figure 5 shows a loss of 70 per cent. with all of the carbon burned

to CO, consequently there is available only 30 per cent. in the gases as sensible heat for the use of the boiler. This shows the incomplete-combustion loss at its theoretical maximum.

Figure 6 presents curve of loss with varying air supplies and constant final temperature of gases, also the theoretical minimum air supply for complete combustion and a range of final temperatures. With combustion of all the carbon to CO, there being available for the use of the boiler 30 per cent. of the heat, if it is assumed that of this the boiler will absorb the conservative amount of two thirds, then the efficiency under these conditions would be 20 per cent. and the loss 80 per cent.; while with the opposite condition, that of complete combustion with the gases at the low final temperature of 400 degrees, the loss could also be 80 per cent. The small loss with extreme range of final temperature to 1,200 degrees, but with an ideal condition of

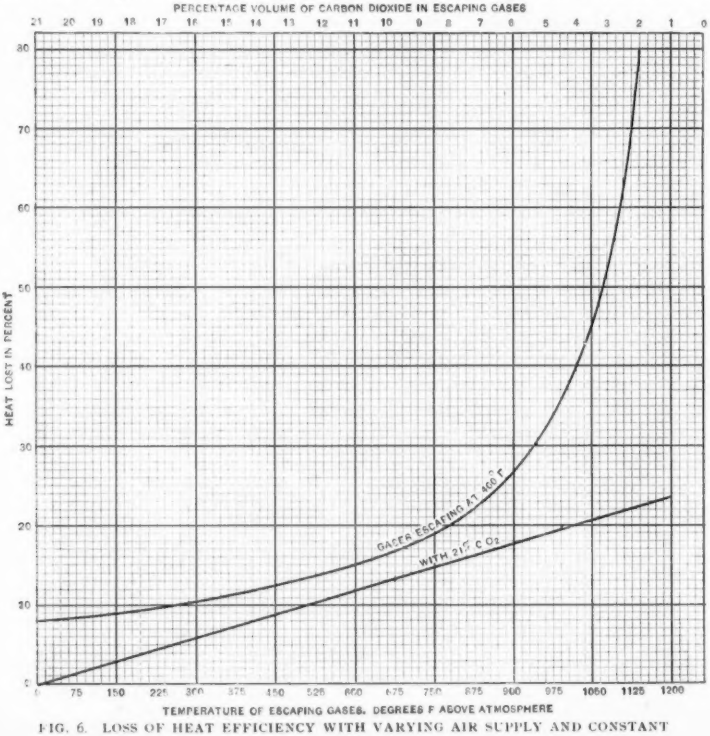

PERCENTAGE VOLUME OF CARBON DIOXIDE IN ESCAPING GASES
21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
HEAT LOST IN PERCENT
80
70
60
50
40
30
20
10
0
GASES ESCAPING AT 400° F
WITH 21% C O2
0 75 150 225 300 375 450 525 600 675 750 825 900 975 1050 1125 1200
TEMPERATURE OF ESCAPING GASES, DEGREES F ABOVE ATMOSPHERE

FIG. 6. LOSS OF HEAT EFFICIENCY WITH VARYING AIR SUPPLY AND CONSTANT FINAL TEMPERATURE.

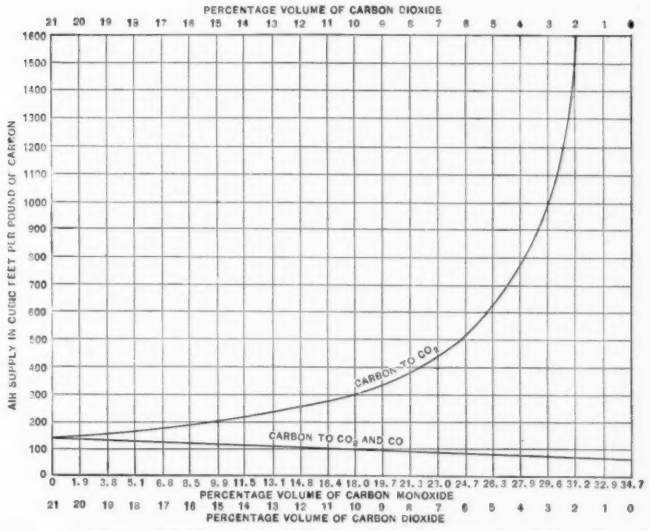


FIG. 7. EFFECT OF VOLUME OF AIR SUPPLY ON COMPLETENESS OF COMBUSTION.

combustion, is most significant in comparison with that shown by the other curve above it at only 400 degrees.

Figure 7 serves to show the volume of air supply with the conditions of combustion presented; the upper curve illustrates why there may be a loss of 80 per cent. at 400 degrees, while the lower curve shows the condition which causes low final temperature with incomplete combustion. This assumed condition must necessarily be one with no unused air, because all oxygen present would combine, and if in excess of the requirement for theoretical maximum volume of CO, would prevent its attainment.

Owing to lack of understanding, many boiler owners not only allow wasteful conditions to continue, but are led into unnecessary and extravagant investments, supposing that they are replacing apparatus with other of superior character. A furnace maker or his agent who is able to make a fairly correct estimate of the losses caused by bad practice and management, will offer to install his furnaces to be paid for if a certain percentage of saving is shown on trial by his apparatus, which will be operated with all of the skill at his command; the result often is that the purchaser discards old apparatus for new, when, if he had improved his practice, he might not only have obtained just as good results, but have saved a large investment cost.

THE MECHANICAL EQUIPMENT OF THE SHIP-YARD.

By Prof. J. H. Biles.

Professor Biles' initial paper was published in the preceding issue of THE ENGINEERING MAGAZINE. In it he dealt with the influence of equipment on the cost of ship-building, the classes of machines required and their arrangement in the plant, the structural work of a ship and the operations involved in its building, and the tools used chiefly in the work of framing.

The discussion following is addressed chiefly to the tools employed more particularly in working, shaping, and fastening the plating of a ship. The unusual space requirements of the illustrations make it necessary to leave the pneumatic tools and appliances for inclusion in the last of Professor Biles' articles, which will be published in our July number.—THE EDITORS.

THE tendency of late years to use plates of as great a length as possible has involved the installation of larger tools for the various processes of their preparation for the ship. At the present day, plates 30 feet in length are not uncommonly used, especially for the larger class of work. The economy of using broad plates has already been discussed under the question of punching machines, and the same remarks apply to long plates. A better and more efficient arrangement of butts in the shell or decks of a ship can be obtained by the use of large plates. Against this must be placed the extra cost per plate of handling due to the greater weight, but in a well-equipped and well-arranged yard, where the amount of manual handling is reduced to a minimum, this item does not assume very large proportions and is off-set by the reduced number of plates to be handled.

Plate bending rolls are now in use in all the larger shipyards. Illustrations are shewn in Figures 22, 23, 24, and 25. This machine is generally the most expensive in a shipyard, costing as much as £5,000. The main part of this machine consists of three strong rollers, two at the bottom and one at the top. The height of the top roller can be altered. The axes of the bottom rolls are fixed in position, but the rolls can be driven in either direction by a reversing engine. In bending a plate, a mould is made to the required shape, or two or three set irons are curved to the required shape at definite parts of the plate. The plate is inserted between the rolls, which are driven round. The

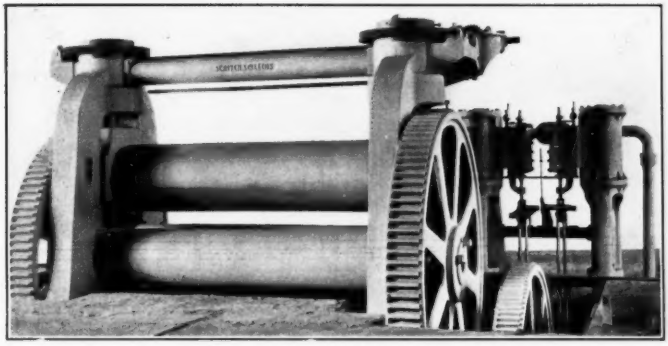


FIG. 21. PLATE-BENDING MACHINE.

For steel plates for gun shields, etc., up to 11-feet wide and 5-inches thick, when hot, and up to 3-inches thick when cold. Top roller is raised and lowered by steam engines. Driven by pair of steam engines with link reversing motion. Scriven & Co.

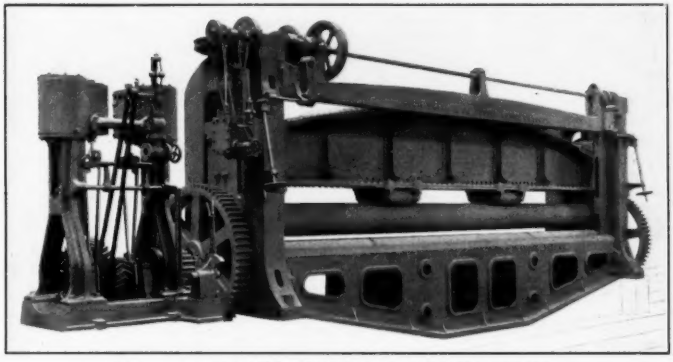


FIG. 22. SHIP-PLATE BENDING ROLLS, ENGINE DRIVEN.

For bending plates up to 35-feet long and 2-inches thick. Two pairs of supporting rollers. Hugh Smith & Co., Glasgow.

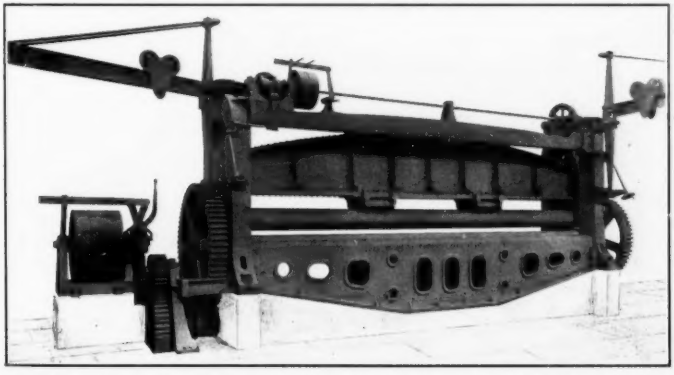


FIG. 23. ROLLS OF THE SAME GENERAL TYPE AS FIG. 22, BUT DRIVEN WHOLLY BY BELTS. ONLY TWO PAIRS OF SUPPORTING ROLLERS.

top roll is then lowered so as to give the plate a slight bend at first. When the plate comes out at the other side, the curvature is tested by the set-iron moulds so that the workmen know how to alter the top roller for the next roll, which is given by reversing the engine and sending the plate back through the rolls. This process is repeated until the plate has the required amount of bend.

Figure 21 shews a powerful set of bending rolls driven by a double-cylinder reversing engine, and having an independent engine for work-

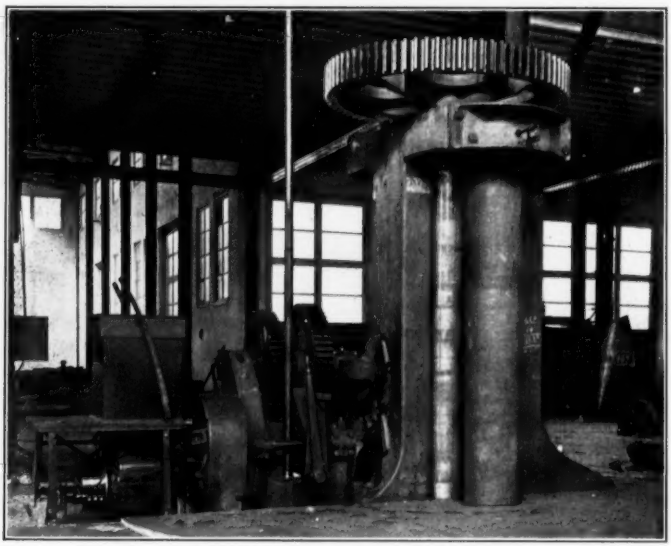


FIG. 24 10-FOOT VERTICAL ROLLS, UNION IRON WORKS, SAN FRANCISCO.

ing the elevating gear of top roll. The framing for this machine requires to be very strong. The rolls shewn in Figure 22 are also engine-driven.

Figure 23 shews a set of rolls driven by belt power, the top roller being worked in the same way. In the larger sizes, like those shewn in the preceding figures, it is necessary to fit girders over the top roller with intermediate bearing rollers, to prevent the bending of the top roller when rolling the plate. Intermediate bearing rollers are also fitted below the two bottom rollers for the same purpose.

The rollers shewn in Figure 25, opposite, are of a lighter type and are designed for working mast plates. When worked in the machine the plate curves round the top roller, and very often the rolled section

of a mast plate is a complete circle. The plate, therefore, forms a complete tube round the top roller. In order to withdraw it, a special frame is fitted at one end of the rolls shewn at the right end of Figure 25. The top half of the framing which supports the rollers is arranged to swing clear, leaving the end of the top roller free. This allows the plate to be withdrawn.

Plate-straightening machines for the heavier plates are now generally fitted with five instead of seven rolls as was formerly the practice. They are to take buckling from plates and to give them a fair surface. The plate is put endwise into the rollers, and as in ship work the breadth of the plate seldom exceeds six feet, the width of these machines does not usually exceed about eight feet.

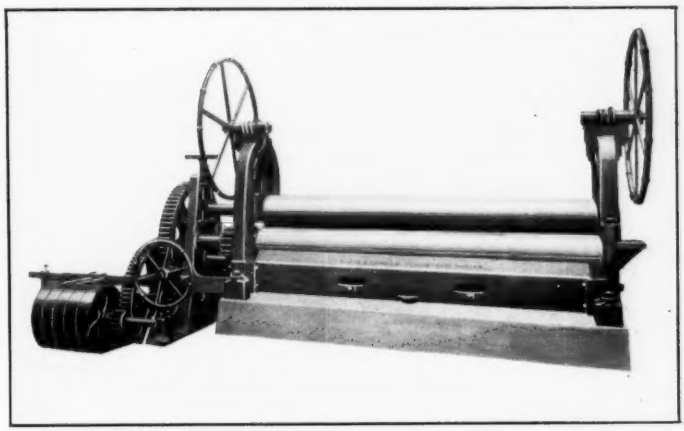


FIG. 25. PLATE-BENDING ROLLS, SUITABLE FOR WORK UP TO ¾-INCH THICKNESS AND 11 FEET 6 INCHES WIDTH.

Top half of housing swings clear for removal of tubes from top roller. Craig & Donald.

Figure 26 shews a seven-roll machine. The rollers in this case are 8 feet 3 inches long and suitable for flattening plates up to 8 feet wide by 1¼ inches thick.

A plate-edge planing machine consists essentially of a table on which the plate lies, and a travelling cutting tool. A series of clamping screws secures the plate, and the cutting tool is geared so as to travel the whole length of the table. See Figure 27. Such a machine should be made to take at one cut the longest plate likely to be used in any part of the work, although they are generally arranged so that the top beam, which contains the clamping screws, is overhung, and thus any length of plate may be planed, though the cutting of a longer

plate involves two fixing operations. In the later types of this tool the plate is held down by hydraulic rams, instead of by clamping screws, although some of these machines have a combination of both systems. Some machines, such as that shewn, have a swivel head to the cutter so as to plane at any angle. This machine is capable of planing up to 24 feet at a stretch and takes a full cut off a 2-inch plate.

Figure 28 is a patent plate-edge and butt planing machine designed to economise time and save floor space by planing the side and end of a plate simultaneously and at one setting. The end of the plate can be

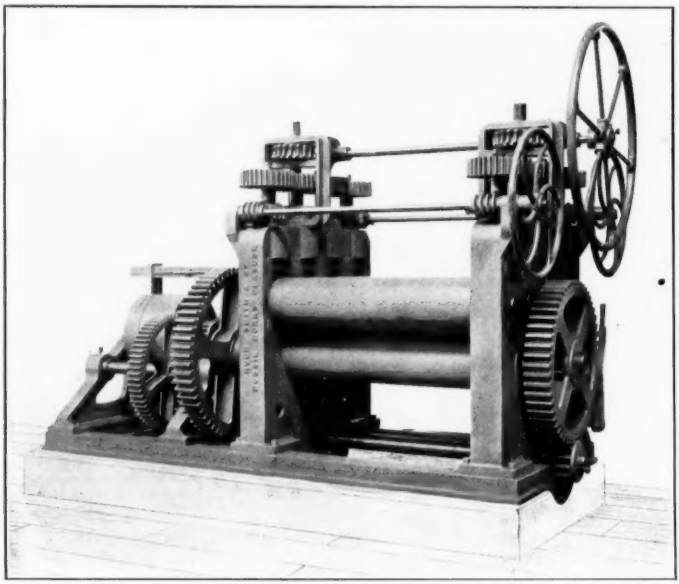


FIG. 26. SEVEN-ROLLER STRAIGHTENING ROLLS.

Capable of flattening plates up to 8-feet wide by 1¼-inches thick. Hugh Smith & Co., Glasgow.

planed at right angles or at an obtuse or acute angle with the side. These machines can be made to plane lengths and widths to suit all requirements, but all machines will admit a plate any length and of any width. These machines are not very commonly used in shipyard, the extra cost and complication of the machine scarcely being repaid by the time saved.

Countersinking machines of the type shewn in Figures 29 and 30 are the most commonly adopted. This machine is designed to work in any position. The gearing carrying the drilling shaft runs along a jib

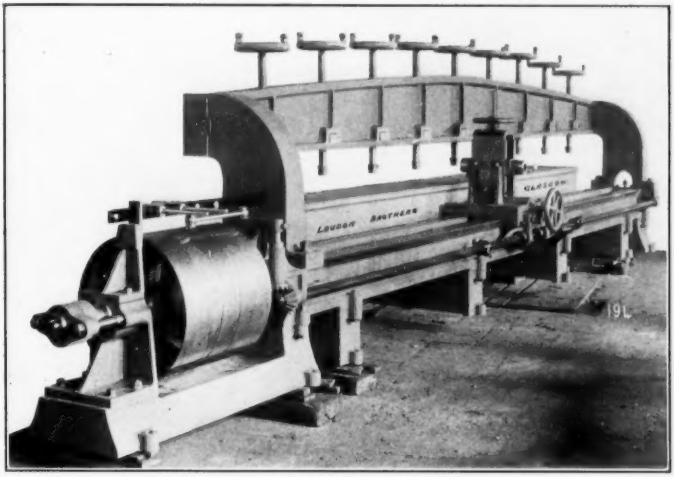


FIG. 27. EDGE-PLANING MACHINE.

which can swing round to any angle. The vertical height of the drill can be altered by raising or lowering the hand lever. These machines should, as a rule, be mounted in groups of two or more, depending upon the size of plate used, in order that as many countersinking tools as practicable may be working upon the plate simultaneously. By this arrangement, the plate when once in position does not require to be moved until it is finished, and the countersinking operation can

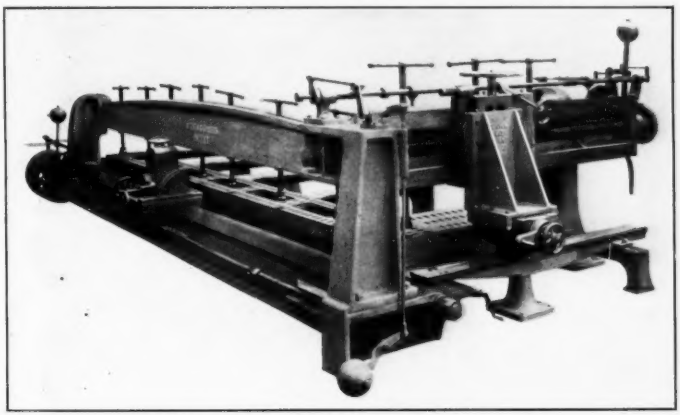


FIG. 28. PLATE-EDGE AND BUTT PLANING MACHINE.
Scriven & Company, Leeds.

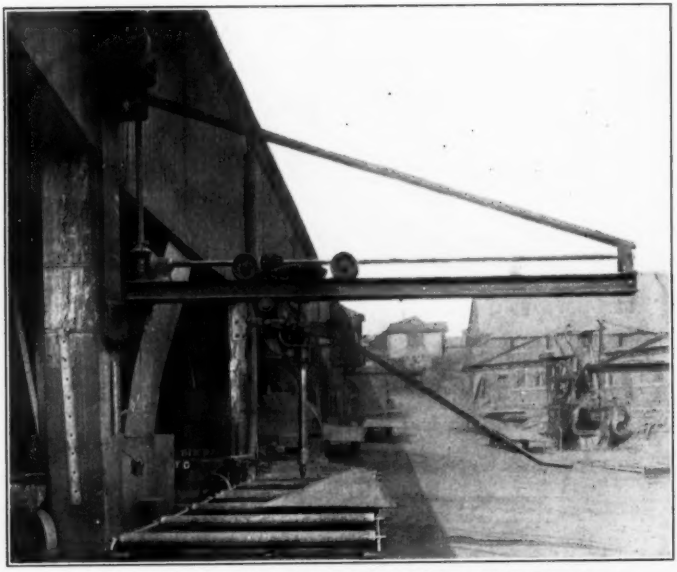


FIG. 29. COUNTERSINKING MACHINE, DOXFORD YARDS, SUNDERLAND.

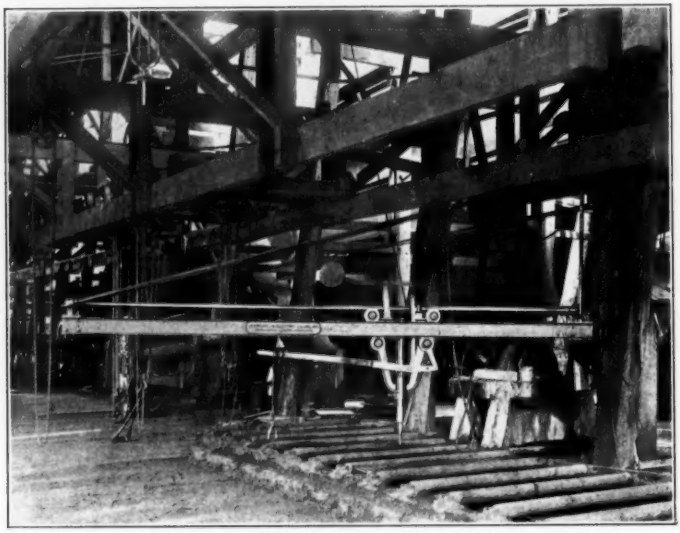


FIG. 30. COUNTERSINKING MACHINE IN THE UNION IRON WORKS, SAN FRANCISCO, U. S. A.

Detrick & Harvey Machine Co., Baltimore.

thereby be done much more rapidly. All plates have to be punched and a very large proportion have to be countersunk, while a much smaller proportion have to be rolled, straightened, and planed. These proportions vary with different types of ships, but are easily determined for any given type of ship. If a yard is consigned to build only one type of ship, the numbers of each type of machine can be determined, and with efficient management a minimum amount of idle time for such machine is obtained; but if the types built in one yard vary, some machines will be fully employed while others will have a lot of idle time. Hence, a yard which builds a variety of ships cannot build any one type as cheaply as the yard which does nothing but that type, other things being equal.

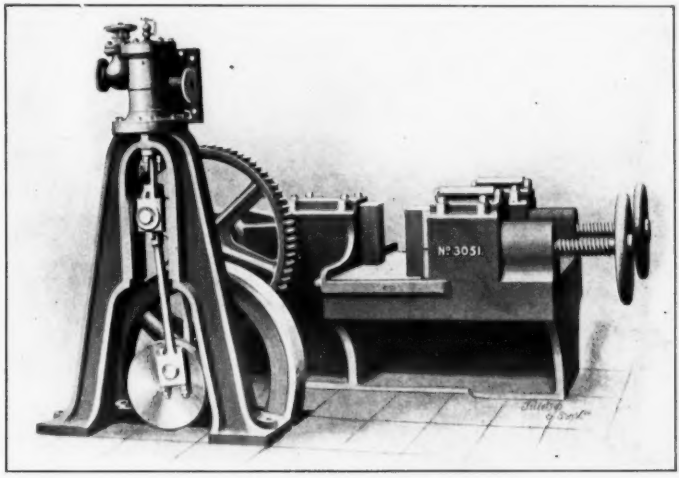


FIG. 31. BEAM OR ANGLE-BENDING MACHINE.
Straightens or bends beams up to 16-inches deep. Craig & Donald.

For bending angles and beams cold a bending machine is employed. The bar or beam is pressed between two bolsters by a ram, as in Figure 31, or is pressed against the ram by the bolsters, as in Figure 34. Figure 31 is a machine capable of bending beams up to 16 inches deep. The ram receives its motion from an eccentric on the driving shaft so that travel of the ram is constant. In order to vary the amount of bend the bolsters can be adjusted by handwheels. In Figure 34 the two bolsters are formed on one slide, which is geared to the driving shaft by an eccentric. The bend is varied in this machine by a hand-wheel on the ram. Figure 33 is a double-ended bend-

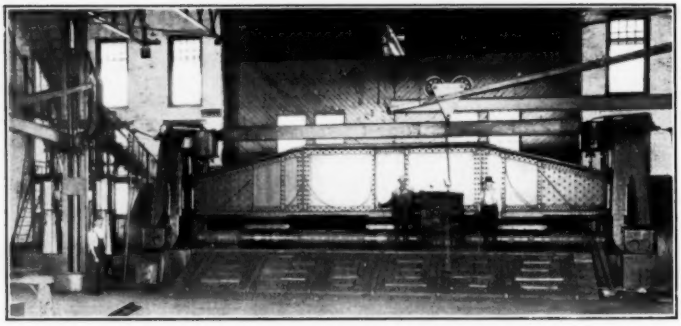


FIG. 32. HORIZONTAL PLATE-BENDING ROLLS, NEWPORT NEWS SHIP BUILDING & DRY-DOCK CO., NEWPORT NEWS, U. S. A.
Handling plates up to 32 feet long and 1¼ inches thick.

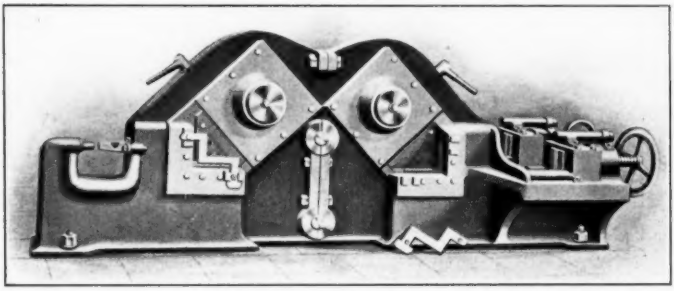


FIG. 33. BEAM OR ANGLE-BENDING, HORIZONTAL PUNCHING, AND DOUBLE ANGLE-CUTTING MACHINE.
Handles 14-inch butterfly or 16-inch ordinary beams. Punches 1⅛-inch holes in 1¼-inch plate, and cuts (in center, right and left) 12-inch by 10-inch by ⅞-inch angles.

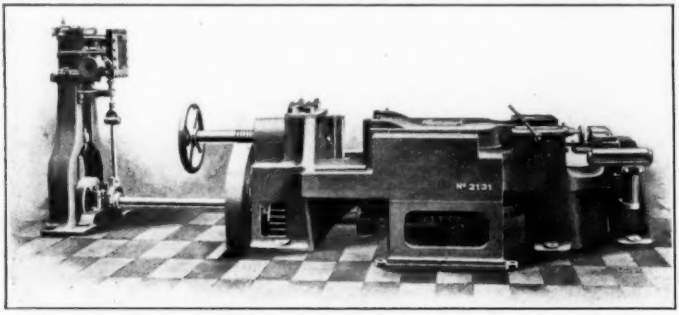


FIG. 34. HORIZONTAL BEAM-BENDING AND PUNCHING MACHINE.
Capable of bending or straightening 14-inch beams and of punching 1¼-inch holes through 1¼-inch plate. The punching die is arranged to punch flanges of H or channel section, from 5-inches deep and upward, or of smaller sections by substituting a smaller die-holder. Craig & Donald.

ing and punching machine for beams up to 16-inch H section, with cutting attachment. Figure 35 is a combined beam or angle bending or straightening, cutting, and horizontal punching machine. It can bend up to 16-inch beams.

One of the tools most recently invented for ship work is the jogging machine. The usual type is shown in Figure 37. In the connections of structures composed of plates, the edges and ends or butts can be connected either by straps or by overlapping. If the latter

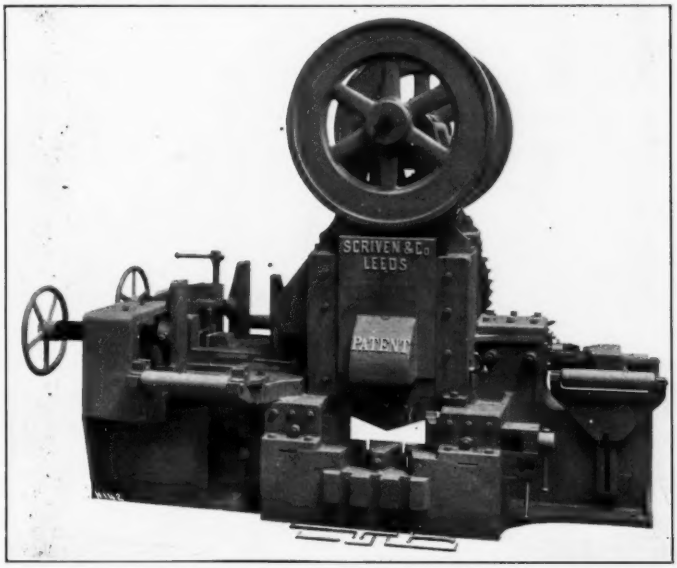


FIG. 35. BEAM-BENDING AND PUNCHING MACHINE, WITH CUTTING ATTACHMENT FOR ANY SECTION.

At one end is combined angle and beam-bending arrangement for bending beams up to 16 inches deep, and horizontal bulb shears for cutting off one side of bulb level with the web to any length for rivetting the knees. The machine will cut part of one leg or angle or Z or notch the same. In the centre is a patent combination for cutting any section of bar any length, up to 15 inches without changing knives. At the other end is a horizontal punch for holes up to 1⅛-inch in any section.

method is carried out without altering the plate, it often happens that liners of the thickness of the plate have to be fitted to help make a fair surface, but if at the edges or ends the plates are bent to overlap no liners are required. This operation is called joggling, and is effected by the joggling machine, which is essentially a pair of rollers each having a flange like a railway-wheel tyre and overlapping each other. A ship built in this way is partly shewn in Figure 38. This

method and the machine for carrying it out were invented and first used by Messrs. Wm. Doxford & Sons, of Sunderland, and the ship in the illustration was built by them.

The saving of time and expense effected by joggling the edges of

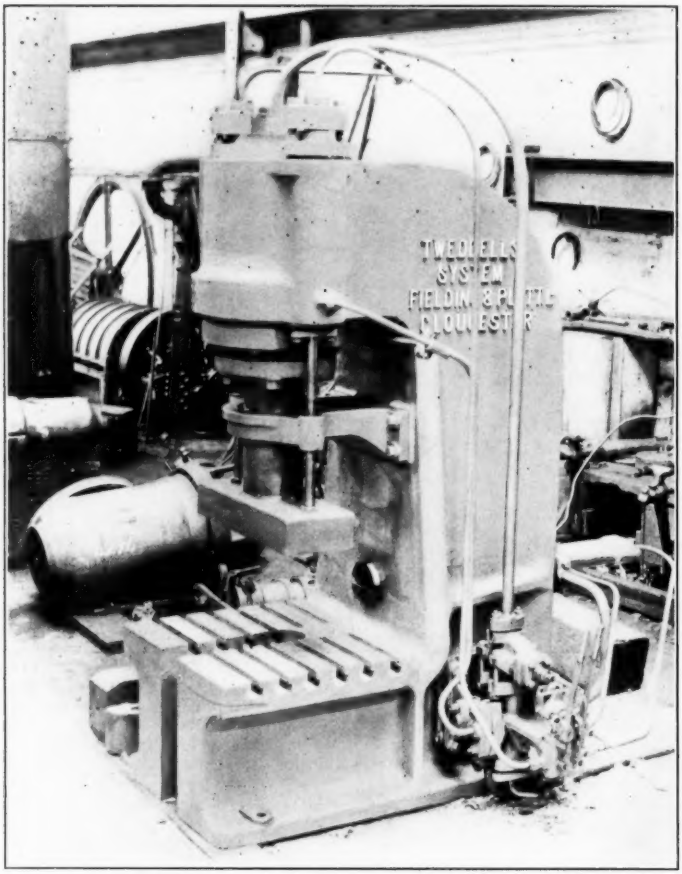


FIG. 36. HYDRAULIC JOGGLING AND BEVELLING MACHINE.

plates, instead of fitting liners or filling in pieces, is evident at a glance. There is also a considerable saving of weight in large steamers; but for the smaller types, with few decks and thin plates, the loss of displacement due to the outside strakes almost counterbalances any saving

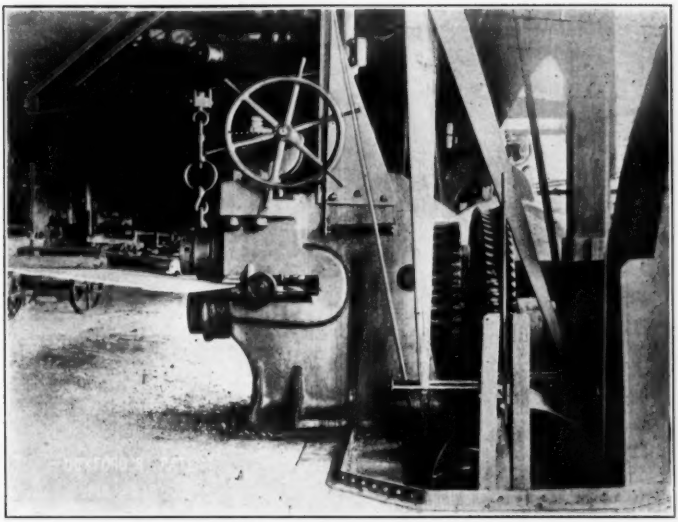


FIG. 37. JOGGLING MACHINE, DOXFORD'S PATENT.

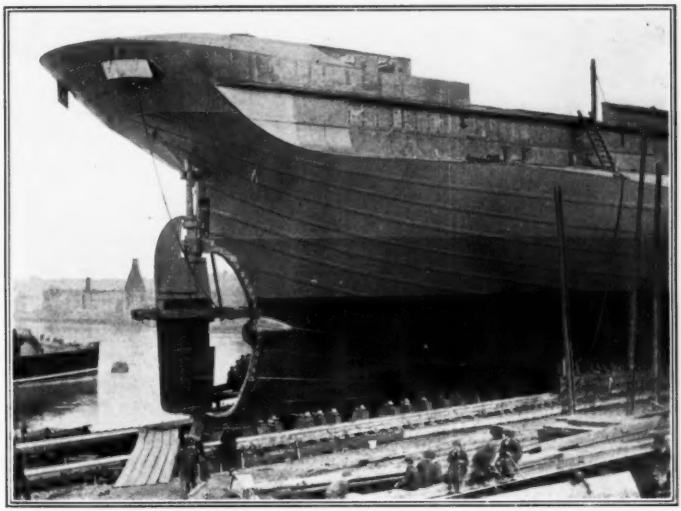


FIG. 38. SHIP WITH JOGGLED SYSTEM OF PLATING.
Built by Doxford, Sunderland.

in weight due to the absence of liners. There is an appreciable difference to the wetted surface of the vessel, and this becomes important at high speed. A disadvantage of joggling is the tendency to crack the plates where the joggling is severe.

A machine which has produced very satisfactory work and at the same time saved a great deal of expense is the bevelling machine, Figure 39. This machine is constructed to do either open or shut bevelling, and is generally mounted on rails so as readily to be brought to the mouths of the furnaces by which the bars to be bent are heated. The bars are run through the machine after being taken out of the furnace and are bevelled before being bent, so that the one heat suffices for the whole operation. In the case of hand work, at least two, if not more, heats are required where there is any excessive bevel upon a bar which has to be bent. At the same time, the flange of the bar is

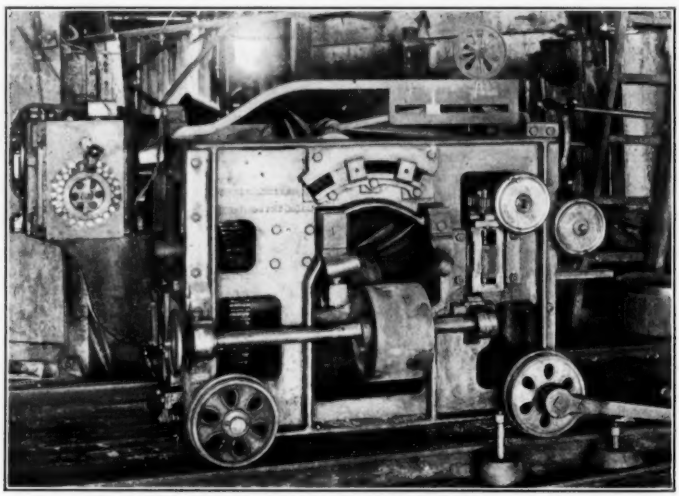


FIG. 39. ANGLE-IRON BEVELLING MACHINE, UNION IRON WORKS, SAN FRANCISCO, U. S. A.
Davis & Primrose, Leith.

seldom straight after the operation, but tends to take a hollow form from the heel outwards. The machine beveller does away with the last objection, as the flanges are bevelled straight from the heel outwards. An indicator on the machine gives the required bevel at any point.

The use of hydraulic power in shipyards in the United Kingdom is not accompanied with serious difficulties from climatic considera-

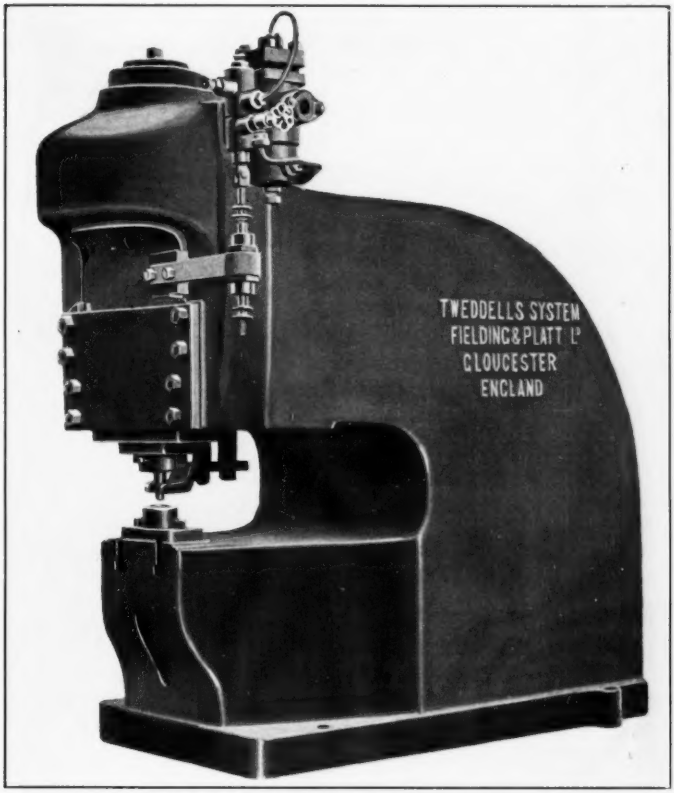


FIG. 40. HYDRAULIC PUNCHING MACHINE.

tions, the duration and severity of frost being rarely sufficient to cause much trouble. For manipulating the heavier class of flanging, punching, and rivetting machine, hydraulic power certainly possesses great advantages over some of the other forms. It is not so delicate and does not require the same attention as electric power, and is on the whole cheaper and can be used in places where direct steam power is not suitable. Few British establishments have as yet adopted compressed-air plants. For rough handling, inseparable from most shipyard work, hydraulic or compressed-air power possesses some advantages over electric power; but the latter is much more flexible in its application, as wires are much more easily led and taken care of than pipes. The operations for which hydraulic power is most commonly

used are for flanging plates, punching man-holes or large lightening holes, and hoisting and rivetting, although tools for nearly all the other operations, such as punching, shearing, etc., may be driven by this method.

Figure 40 is a hydraulic punching machine. Figure 42 is also a punching machine, but can be used as a rivetter as well.

Flanging machines for the heavier plates should be capable of taking in the longest plates used. It is possible to flange thin plates in small lengths at a time without injury to the plates, so that a machine with sufficient scope for flanging short lengths of plates, such as brackets, intercostals, etc., can also be used for lighter work such as

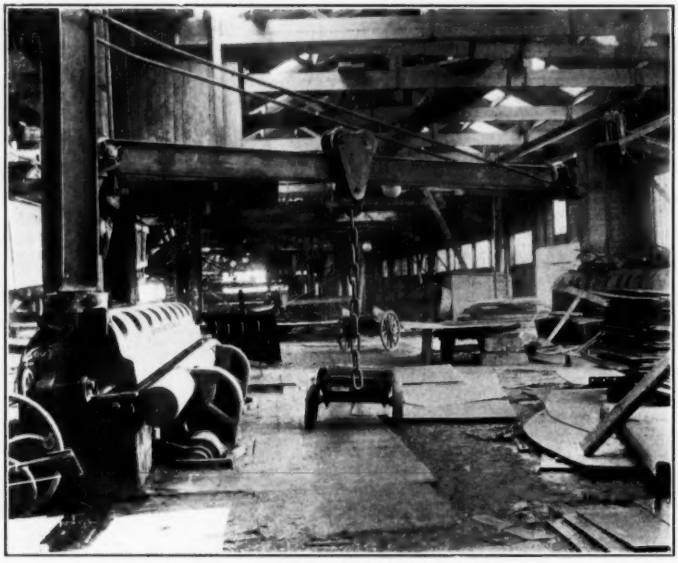


FIG. 41. HYDRAULIC FLANGING MACHINES.

casing plates. The type of machine in general use for the heavier work, such as keel plates, bulkhead plates, etc., is one of the form shewn in Figure 41. Here the plate is inserted below a beam forming the back of the machine, and is fixed by a lower beam which is moved up an inclined plane until it jams the part of plate inserted. The roller shewn in front is then moved up by hydraulic power and gives the plate the required flange. Figure 43 is a hydraulic keel-plate bending machine capable of bending both sides of a keel plate at the same time. Two hydraulic cylinders at each end give the power necessary

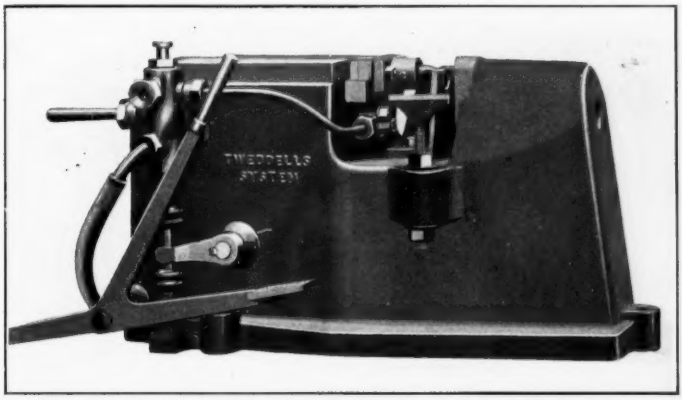


FIG. 42. HYDRAULIC PUNCHING AND RIVETTING MACHINE.

for bending the plate. The sides may, however, be used independently of each other if required. Figure 44 is a hydraulic flanging machine of the same type as Figure 42, only the roller when flanging moves downward, instead of upwards as in Figure 42. Hydraulic cranes are fitted at each end of this machine for handling the plates.

Figure 47 shows a powerful hydraulic oval or man-hole punching machine for punching at one stroke round or square holes up to 21 inches by 18 inches in ¾-inch thick plates. The machine has a bed-plate upon which the dies are fixed, and a cross-head in which is placed

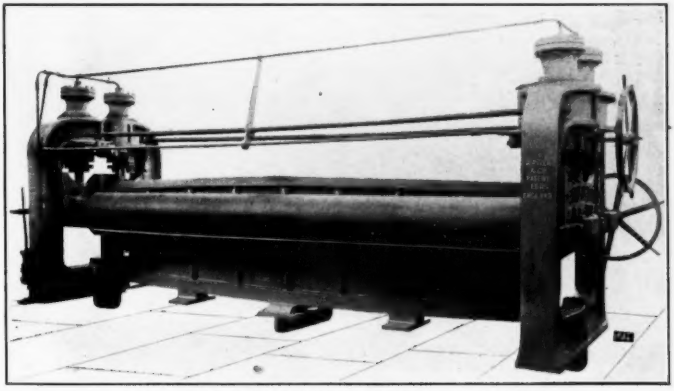


FIG 43. HYDRAULIC KEEL-PLATE-BENDING MACHINE.

Bends both sides at once uniformly to a channel section, either parallel or tapered to any degree of twist. Will also flange stringer plates, bulkhead plates, floor plates, knees, etc. Scriven & Co., Leeds.

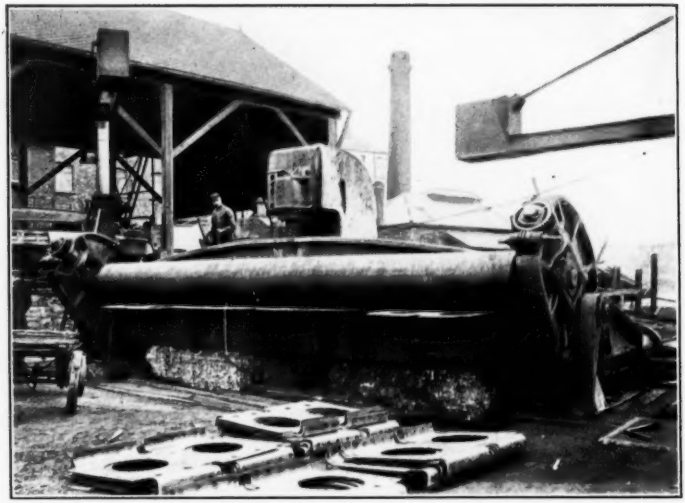


FIG. 44. HYDRAULIC PLATE-FLANGING MACHINE, DOXFORD, SUNDERLAND.

FIG. 45. HYDRAULIC BENDING MACHINE, YARDS OF UNION IRON WORKS, SAN FRANCISCO, U. S. A.

the hydraulic cylinder and ram for carrying the punches. Bed-plate and cross-head are held apart by four strong steel pillars to allow plates 6 feet wide to pass through. Figure 46 is a hydraulic man-hole punching machine which can also be used for joggling or bevelling.

Figure 48 is a patent hydraulic shearing and bending machine. This machine is provided with two angle-bar cutters in the centre of the machine for cutting either right or left hand. At the end of the machine there is an angle-bar and beam-bending and straightening

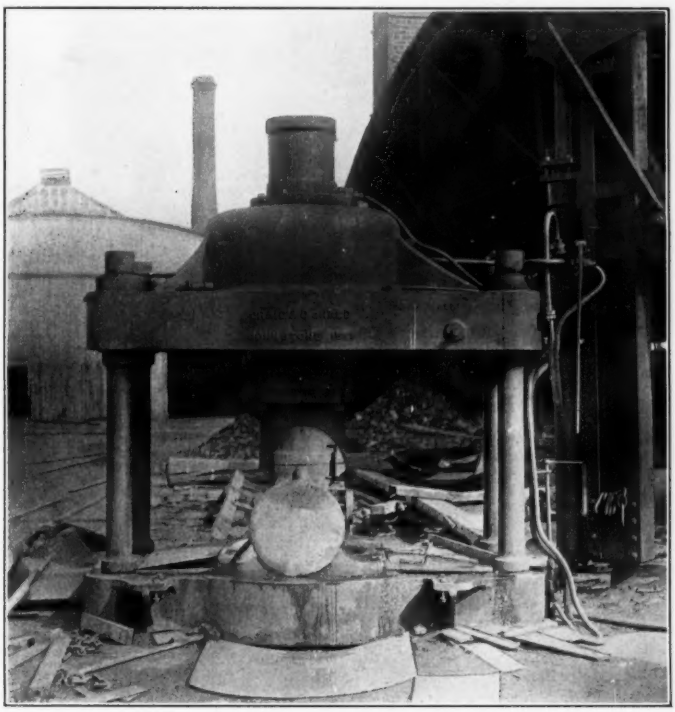


FIG. 46. HYDRAULIC PRESS FOR FLANGING, JOGGLING, OR PUNCHING MANHOLES.
Built by Craig & Donald for Denny Bros.

arrangement to admit beams up to 12 inches deep. The power is obtained by a hydraulic cylinder which is arranged to work at two powers with the same water pressure; the larger power to be used for larger sections of bar, etc., and the smaller power for the lighter sections, thereby effecting a considerable economy in the consumption of water.

The use of hydraulic rivetting machines is now almost universal in Great Britain. Certain parts of a ship's structure, such as the frames and floors, are usually assembled at the head of the slipway upon which the vessel is to be built, and at this point are placed two or more ma-

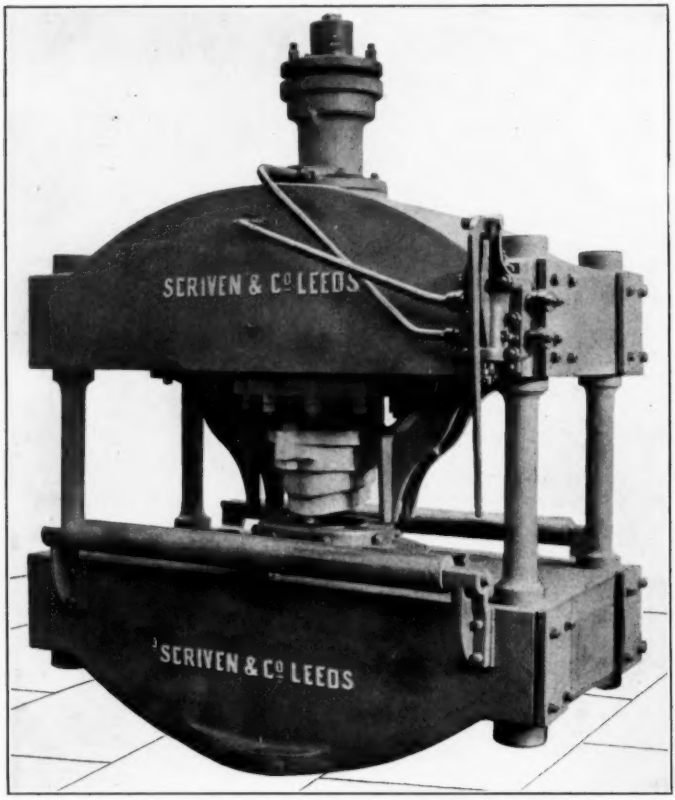


FIG. 47. HYDRAULIC OVAL OR MANHOLE PUNCHING MACHINE.

Punches at one stroke large round or square holes up to 21 inches by 18 inches in 1¼-inch plate. Plates 6 feet wide can pass between the four strong steel pillars which hold apart the bed-plate, on which the dies are fixed, and the crosshead carrying the hydraulic ram and punches.

chines slung from the jib of a fixed crane by means of small lifts. A light staging is erected on which the parts rest while being rivetted together. This operation usually takes place while the keel is being laid and the staging being erected. In the construction of a steamer

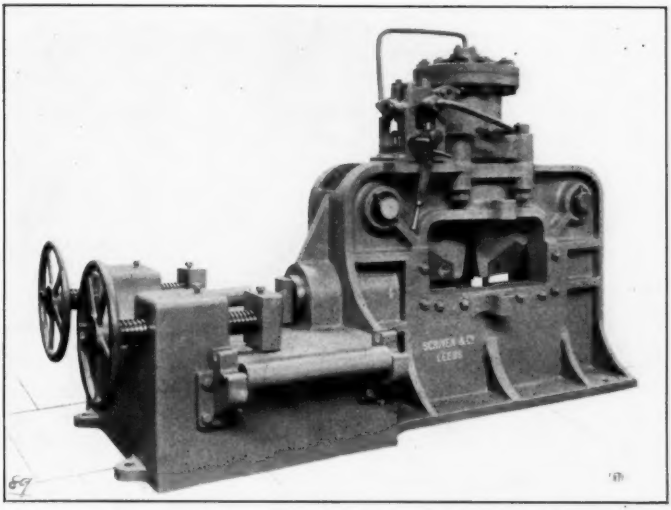


FIG. 48. HYDRAULIC SHEARING AND BENDING MACHINE.

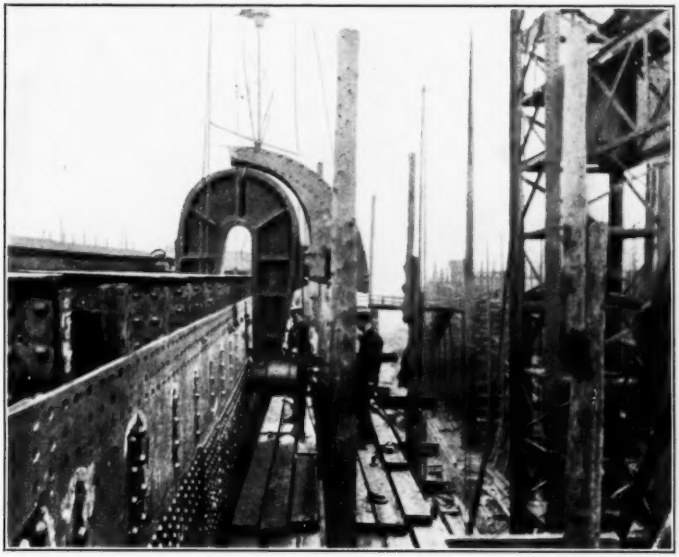


FIG. 49. PORTABLE HYDRAULIC RIVETTER AS USED ON THE OCEANIC, YARDS OF HARLAND & WOLFF, BELFAST.
Fielding & Platt, Ld.

with a double bottom (see midship section, Figure 50) the floors and connecting angles are rivetted first. These are then lifted onto their position marked off on the keel, shored up, and faired, while the frames and connecting brackets are being rivetted. After the margin plate is

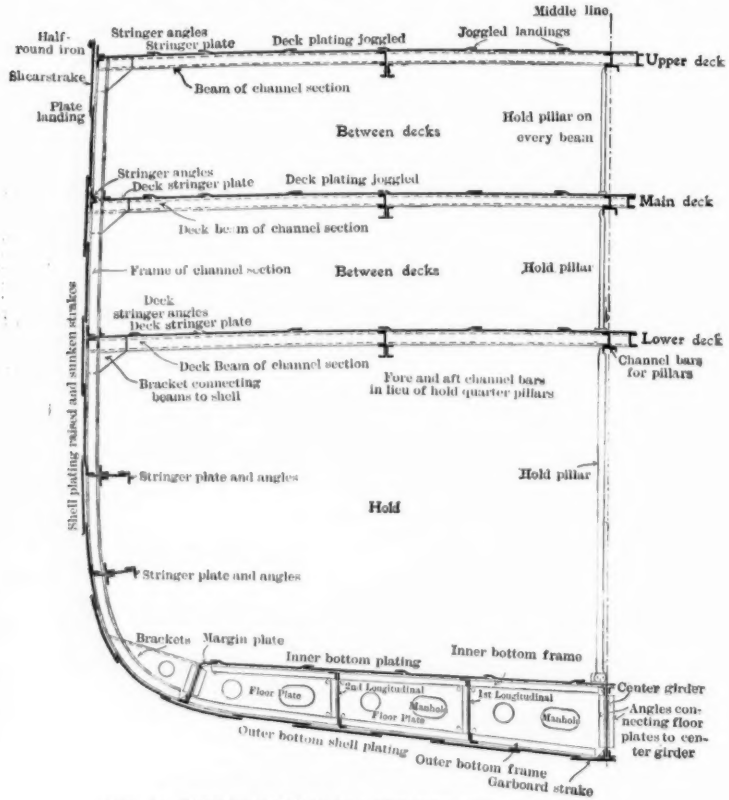


FIG. 50. MIDSHIP SECTION OF A STEAMER 500 FEET LONG

ON THE DOUBLE BOTTOM PRINCIPLE

fitted the frames are lifted into position and faired. Figure 4 gave a view of the framing at this stage of construction. The rivetters used in the work over the light staging are of a light pattern (see Figures 49, 51 and 52). No great gap is required, as in the framing work at this stage there is no corner work to do.

The rivetter shewn in Figure 51 is merely a strong frame forming

a gap at the end of which are the rivetting dies. One of the dies, the closing die, forms the ram of the hydraulic cylinder. This rivetter is provided with a clip, by sliding which along the frame the machine can be made to work with the cylinder underneath, instead of above, as shewn, or in any intermediate position.

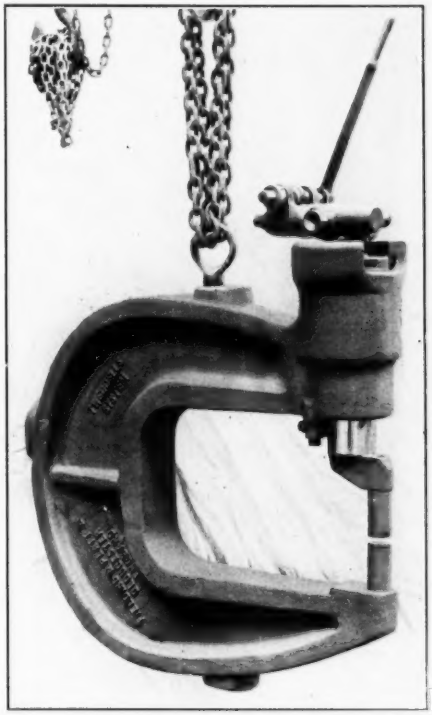


FIG. 51. PORTABLE DIRECT-ACTING HYDRAULIC RIVETTER FOR SHIP'S FRAMES. USUALLY SUSPENDED BY A CLIP.
Tweddell System. Fielding & Platt, Gloucester.

Fig. 54 is a rivetter of the same type but provided with a bow hanger. The machine in this case rotates on the gudgeon through a complete circle, and in order to suspend it with the arms horizontal it is necessary only to connect the swivel onto the gudgeon instead of to the end of the bow. In moderate sized vessels the whole of the frame, reverse frame, floor, and intercostal angles and beams may be rivetted together before erection. In a few cases the beams may not come exactly fair with the rest, but with fair laying off and templating there should be no difficulty in obtaining a fair deck. Even if a few beams have to be cut and re-rivetted after they are in place, there is a great saving in time and expense by adopting the method stated above.

With suitable arrangements for carrying them, hydraulic rivetting machines may be used for almost any part of a vessel, except where flush-rivetting is required. After the bottom framing has been erected, small travelling cranes for carrying these machines may readily be mounted on travelling rails. In this way all intercostals, keelsons, side stringers, may be hydraulic rivetted. When it is re-

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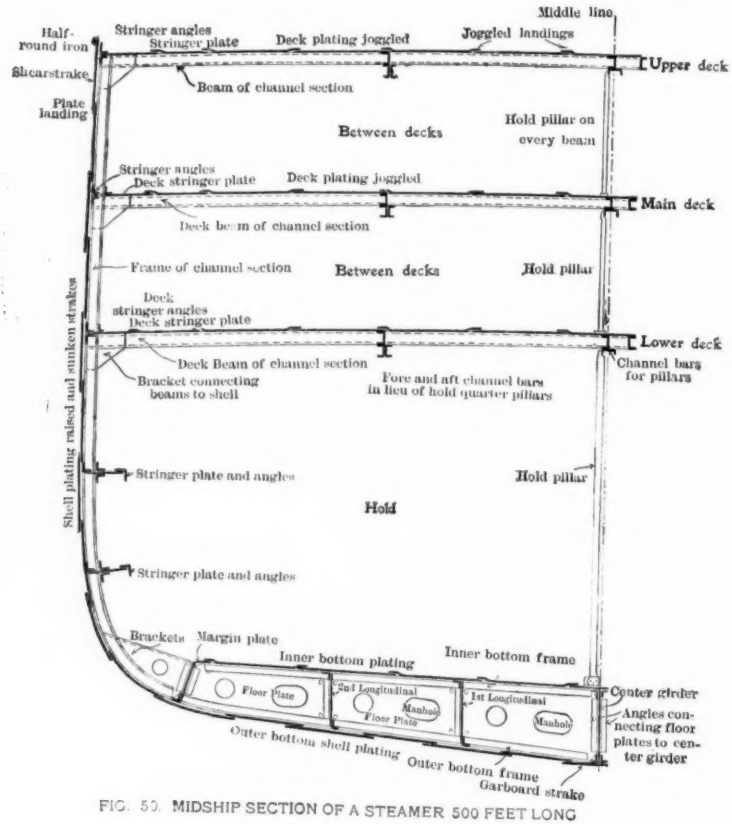

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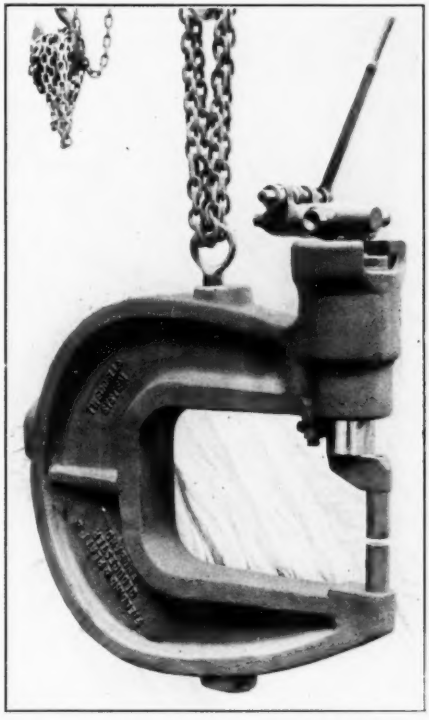


FIG. 51. PORTABLE DIRECT-ACTING HYDRAULIC RIVETTER FOR SHIP'S FRAMES. USUALLY SUSPENDED BY A CLIP.

Tweddell System. Fielding & Platt, Gloucester.

With suitable arrangements for carrying them, hydraulic rivetting machines may be used for almost any part of a vessel, except where flush-rivetting is required. After the bottom framing has been erected, small travelling cranes for carrying these machines may readily be mounted on travelling rails. In this way all intercostals, keelsons, side stringers, may be hydraulic rivetted. When it is re-

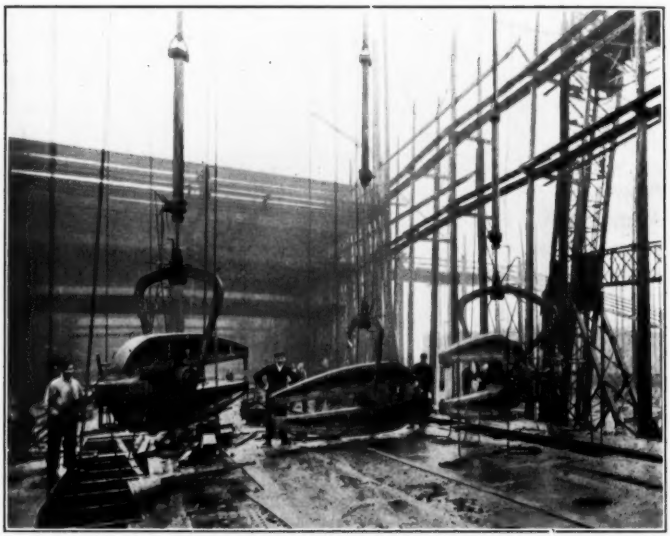


FIG. 52. HYDRAULIC RIVETTING MACHINES AT WORK ON INNER BOTTOM, S. S. OCEANIC. YARDS OF HARLAND & WOLFF, BELFAST

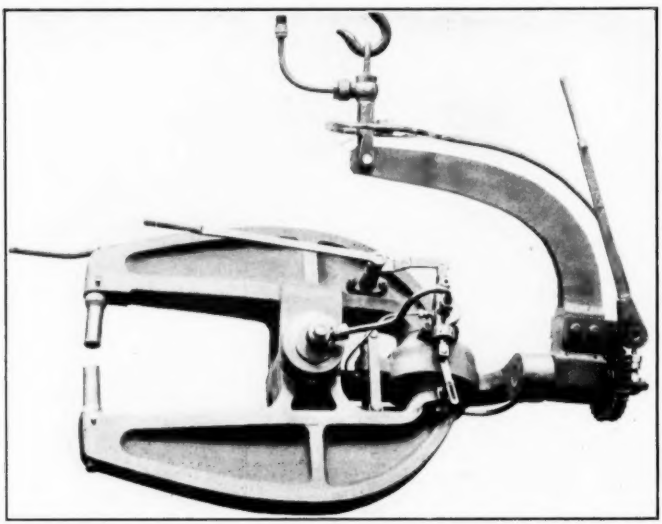


FIG. 53. PORTABLE HYDRAULIC RIVETTER HINGED TYPE FOR GENERAL WORK

Fielding & Platt, Ld.

membered that the saving effected by the use of hydraulic rivetting may amount to from 30 to 40 per cent., to say nothing of the superior workmanship, the advantage of so arranging the work that machine work may be used whenever possible is evident. In the case of double-bottomed vessels nearly the whole of this plating may be machine rivetted. The machines for this class of work require to have a much larger gap than those just considered, except perhaps those used for intercostal work in the inner bottom, and this means a heavier and more cumbersome machine to handle, and involves the use of correspondingly heavier cranes or some arrangement such as a travelling gantry.

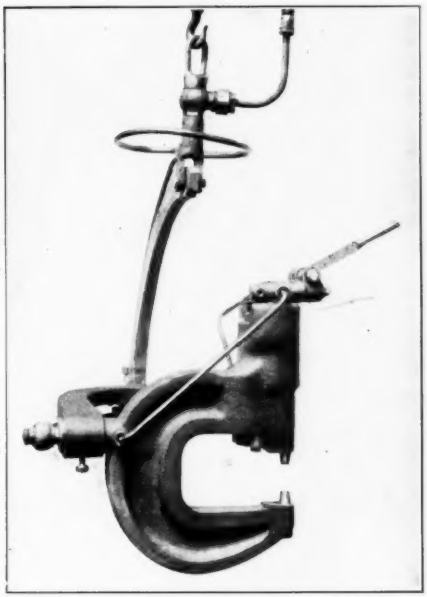
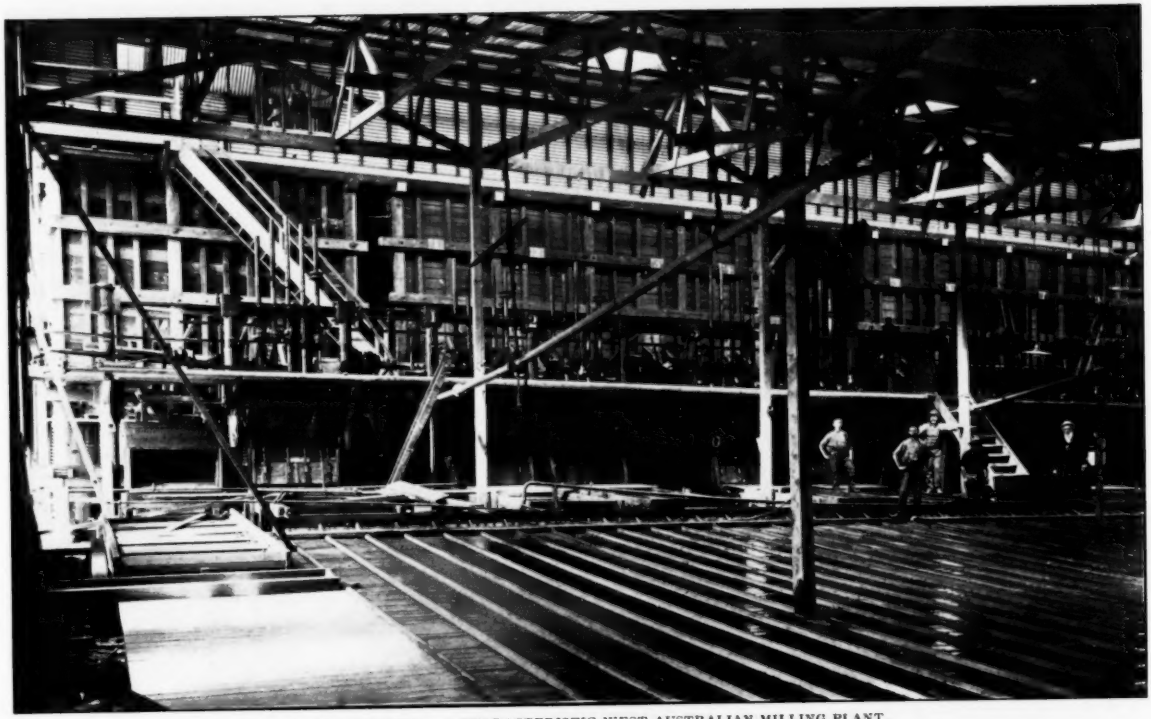


FIG. 54. SMALL LIGHT DIRECT-ACTING HYDRAULIC RIVETTER.

With special compound hanger for being slung in any direction. Fielding & Platt, Ld.

Figure 53 shows a portable hydraulic riveter which is used for this part of the construction. The rivetting dies are clear of the hydraulic cylinder, so that they can get into corner work about the intercostals in the bottom. The levers carrying the dies oscillate on a strong steel centre pin or gudgeon. The hydraulic cylinder and ram are placed at the other end of these levers, and by making the centre line of this cylinder follow the radial path of the arms of which the cylinder forms the outer end, connecting rods between the two levers are avoided. The thickness of the sheerstrake plates and doublings in the large class of vessels has made hydraulic rivetting most imperative owing to the correspondingly large size of rivets.

The discussion of pneumatic tools is necessarily left for the succeeding article, which will conclude with a review of the upkeep of tools, and the general arrangement of the ship-building plant.



THE IVANHOE MILL. A CHARACTERISTIC WEST AUSTRALIAN MILLING PLANT.

GOLD MINING AND MILLING IN WESTERN AUSTRALIA

By A. G. Charleton

V.—MILLING AND CYANIDING PRACTICE AT KALGOORLIE.

Mr. Charleton in this paper concludes the comprehensive review of the Westralian mining field begun in this Magazine in February last. His preceding papers have dealt with topography, geology and general conditions, the dry-blowing process, the water problems of the field, and mining methods and costs.—THE EDITORS.

THE ore-treatment works of West Australia are of three principal classes—mills for crushing the brown-stone, cyanide works for the treatment of oxidised mill-tailings, and sulphide works.

No particular difficulty has been experienced in treating the brown-stone, although, owing to small and inefficient installations, scarcity of water, and high prices, it entailed considerable cost in the early days of the field; and no doubt in some cases there were heavy losses of gold in the tailings. Most of this gold, however, has since been recovered in the cyanide works erected for the purpose. In recent years, with larger and better-equipped mills, improved management, and cheaper means of communication, the cost of milling by wet crushing and amalgamation has been brought down to more reasonable figures. The principal metallurgical difficulty arose from the sliminess of the ore, caused by the presence of silicates of magnesium and alumina and hydrated oxides of iron which, according to H. P. Woodward's estimates, amount to over 40 per cent. of the entire lode stuff. He also expresses the opinion that the tailings of the more modern mills carried as a rule not more than 8 dwts. of gold per ton, which is probably not much under the mark, and considering the nature of the ore, its richness, the fine state of division of the gold, and the quality of the water used, is not a bad showing. Speaking of an earlier date, however, Baron Sloet van Oldruitenborgh remarks that several existing heaps of tailings, carried ¾ of an ounce to 2 ounces of gold per ton.

Mr. G. J. Bancroft* gives a screen analysis of what he regards as a typical milling-ore in this camp:—

0.8	parts per	100 remain on a	25	mesh screen.
0.98	"	"	30	"
9.34	"	"	40	"
16.63	"	"	60	"
17.43	"	"	80	"
5.50	"	"	100	"
49.32	"	passed through	100	"

Following which he gives a chemical analysis of a similar ore:—

	Per cent.
Silica	48.43
Iron	10.4
Alumina	1.98
Lime	9.86
Magnesia	2.03
Sulphur	3.66
Copper	6.35
Calculated	
Carbonic Acid	7.75
Oxygen in Oxide of Iron	3.05
Alkalies, etc., undetermined	6.49
	100.00

From this he draws the deductions:—1.—That the 50 per cent. of slimes present will cause trouble by packing. 2.—That the 10 per cent. of lime present (irrespective of magnesia) places chlorination out of the question.

The grade of the ore milled, as well as the fineness to which it is crushed, no doubt to some extent influences the grade of the tailings; and the increasing muddiness of the water, when pumped back over and over again without being properly settled, as it used sometimes to be when mining first started, contributed to the losses referred to, quite apart from any injurious action the salts in the water might have. Bergrath Schmeisser appears to think that less than 55 to 60 per cent. of the gold was saved in the older mills, whilst Baron Oldruitenborgh asserts that they hardly ever extracted more than 65 per cent., and then only when dealing with the most perfectly oxidised ores treated, the average being probably about 50 per cent. These losses may be ascribed to the amorphous unamalgamable (rusty) state of some of the ochreous ore, besides float gold which escaped the plates, in addition to a certain proportion of gold locked up in sul-

* Kalgoorlie, West Australia, and its Surroundings." Trans. Am. Inst. of Mining Engineers. Feb., 1898.

phides, which the ores carried even in the upper levels. To obviate losses of this sort, some of the mining companies erected Berdan or other pans, by which they succeeded in saving an additional 10 to 20 per cent. of the gold originally contained in the ore. Blankets were put in, in addition, to save the coarsest sulphides and tellurides that escaped, as well as some of the amorphous gold. By these means they obtained a certain quantity of concentrates, worth from 2 to 40 ounces of gold per ton, which were shipped to smelters.

The largest batteries at this period contained thirty stamps, more often only five to ten heads, which crushed from 1½ to 2¼ tons per stamp-head per day—a small showing, compared with 3½ to 6 tons per stamp-head crushed in recent years in South Africa, in mills often containing eighty to two hundred and forty stamps each; there are various reasons, however, why it will not pay as a rule to run through the soft brown-stone of Western Australia so rapidly; partly because its exceptionally clayey consistency either tends to clog the mortar and plates, or involves a heavy consumption of that most expensive commodity, water; partly because its much higher grade would entail liability to a large escape of fine free gold with the tailings. This affords an excellent illustration of the fact that all ores cannot be treated alike, even for the extraction of the free gold.

The following table, given by H. C. Hoover,* shows the gradual growth of the industry in Western Australia, as indicated by the size and number of the mills in each district, the tons of ore crushed, and the yield in 1897; but, as will be seen later, as the tonnage crushed has increased the grade of the ore milled has naturally fallen.

District.	No. of Stamps.	No. of Mills.	Av. No. of Stamps per Mill.	Tons of Ore Crushed.	Total Yield, Av. Ozs.	Bullion. per Ton. Dwts.
Coolgardie	329	24	13.3	9,196¾	8,684¼	18⅞
E. Coolgardie (Kalgoorlie)	265	15	17.6	18,402½	31,735	34½
North East Coolgardie	182	16	11.4	4,123¼	3,729¾	18
Broad Arrow	206	15	13.7	2,632	1,791¾	13½
N. Coolgardie	318	24	13.2	2,665	5,284	39⅝
Mt. Magnet	128	13	9.8	2,752¾	5,145¾	37½
Yilgarn	125	7	17.8	2,855¾	1,148¾	8
Dundas	186	16	11.6	2,631	2,797½	21¼
Murchison	445	33	13.4	6,788½	7,802½	22⅞
E. Murchison	48	4	12.0	1,949½	2,907¼	29¾
Yalgoo	40	5	8.0	516	644½	24⅞
Pilbarra	15	2	7.5	407½	603¾	29¾
Peak Hill	20	2	10.0	447	1,734	77⅔
Northam	80	1	80.0			
Totals	2,387	177	13.4	55,367½		26¾

* *Mineral Industry*, Vol. VI., The Working Cost of West Australian Mines.

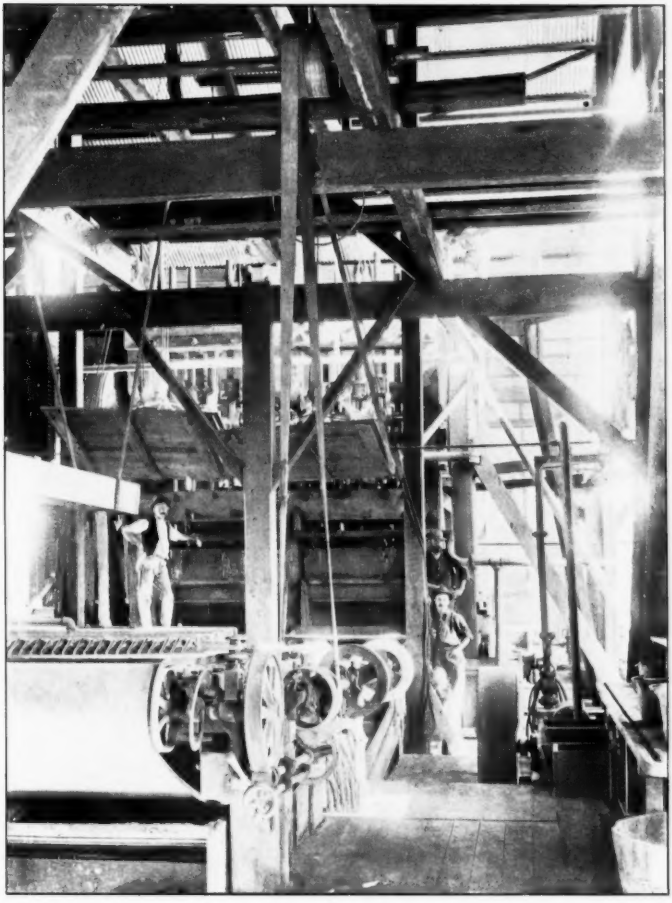
Two somewhat different types of crushing and amalgamating machinery have been employed in milling, viz.:—ordinary stamp batteries and Huntington mills.

Huntington mills have done excellent work, both at the North Boulder mine, where they were first introduced, and at the Oroya, which latter plant, consisting of three mills, crushed 26,954 tons in 1899 for a yield of 10,722 ounces of bullion. Between September 1, 1896, when crushing commenced, and November 16, 1896, the North Boulder in its old original mill treated 533 tons for a yield of 1,160 ounces, giving an extraction of 2¼ ounces per ton with a loss, as shown by assay, of 10 to 14 dwts. in the tailings, representing a yield of about 78 per cent.

The results of this trial were deemed so satisfactory in point of extraction and cost that another 5-foot mill was bought, and this, together with the old one, is still running, with the stamps which were afterwards added to the plant.

The comparative slowness of its discharge, and the rubbing action to which the free gold and gold in combination with other minerals are subjected in a Huntington mill, I am inclined to think, give it an advantage over stamps in the matter of extraction, when treating an ore like the Kalgoorlie brown-stone. Mills of this type are excellent amalgamators, are comparatively cheap and simple to erect, and take less time to put up than stamps, enabling a mine when in the stage of a prospect to get to work quickly, to prove its value on a milling basis, and to earn profits when perhaps it could not afford to stand the cost and delay entailed by the erection of a large battery; these mills require little power, and are cheap to run. They are not, however, so well suited as stamps for large outputs, when dealing with hard-ores. The capacity of a 5-foot mill, I reckon, is liable to fall to about 13 or 14 tons per 24 hours, if fine screens are used, when any considerable quantity of unoxidised ore is mixed with the stone crushed. A mill will, however, put through 17 or 18 tons of softer mill-rock, and would probably crush more, with careful feeding and coarser screens, if the stone is first broken fine in the rock-breaker.

At the North Boulder, the mills are provided with automatic feeders (the ore being previously broken in a stone-breaker and passed through a grizzly). The ore, after crushing in the Huntington, passes over a length of 9 to 10 feet of silver-plated-copper table-surface, 5 feet in width, one table being broken by a drop of two inches and a shallow well, whilst the other has a double-drop well in the middle and a drop of 6 inches at the foot of the second plate. The



NORTH BOULDER STAMP BATTERY.

plates have an inclination of about 1⅓ inches per foot run, and additional clear water is supplied by a perforated pipe at the head. Below both mills, there is a set of blanket-tables, 11 feet in length and 5 feet in width, each divided into four strakes, pitched on a grade of about 1.4 inches per foot. Their purpose is to collect any free gold or amalgam that might escape the mills. The screens are No. 40 diagonal-slot, without any burr, and the mills are run at 65 to 70 revo-

lutions per minute, requiring some 700 gallons of water per hour, and are charged with about 70 pounds of mercury.

The cheapness with which mills of this class can be operated is shown by the results achieved at the Spanish Mine, Nevada Co., Cal.,* and the costs at the Oroya are shown in the table below:

	Twelve Months to Sept. 30th, 1899.	Six Months to March 31st, 1900.
Tons crushed	25,234	13,601
	s. d.	s. d.
Water, " "	2.0	1.8¾
Wood, " "	1.5½	1.6¾
Supplies, etc., " "	.10	1.5½
	7s.11½d.	8s.9d.

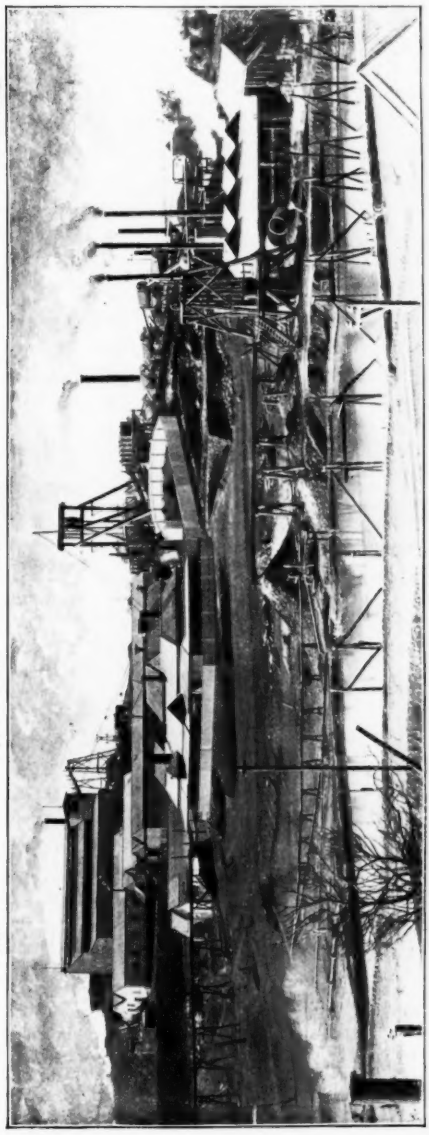
The costs on a large scale at North Boulder cannot be given exactly as, being a composite mill, the cost of labour, water, fuel, etc., used by each class of machinery, cannot be kept separate.

The following particulars of typical mills will serve to illustrate the important features of the milling practice in the battery plants.

The Lake View 50-stamp battery, which I saw in 1898, struck me as being a well-erected and arranged plant, besides being the largest on the field. The ore is crushed in a Gates crusher at the shaft, and elevated by a travelling wire rope-way with buckets to the top of the building, where it is trammed and dumped into a line of bins at the back of the stamps. The stamps weigh 900 pounds, have a fall of 6 inches, and are run at 90 drops and fitted with gib-tappets. They are driven by a compound engine with cotton ropes running in grooved pulleys. The ore feeders are of the Challenge pattern, and it is stated that 4 tons per stamp head, or 200 tons per diem, were being crushed in the autumn of 1898. The gold is caught on amalgamated copper plates and canvas strakes, whilst the tailings, which are saved, are treated by cyanide as described in its proper place. It may be added, however, that this combined treatment is stated to save 90 per cent. of the gold contained in the brown-stone, whilst during the year ending August 31st, 1898, 64,687.7 ounces were obtained from the battery, by the amalgamation treatment of 57,725 tons of ore at a cost of 10s. 1.2d. per ton, and 56,506.47 ounces in 1899, by the treatment of 81,866 tons, at a cost of 6s. 10.463d. per ton.

The Lake View South 20-stamp battery is of a different type from that just described. It is built on a graded mill site, on the hill behind the mine. The five floors are devoted:

* The Choice of Coarse and Fine Crushing Machinery and Processes of Ore-Treatment, by A. G. Charleton; Trans. Federated Inst. of Mining Engineers, page 359 (Paper No. VII.).



GENERAL VIEW OF THE LAKE VIEW CONSOLS.

(1) To the Blake crushers, ore-bins, Challenge feeders, stamps and amalgamating table. (2) To grinding-pans. (3) To Frue vanners. (4) To amalgamating pans. (5) To settlers. The ore passes automatically from one stage in the process to another. The stamps weigh 900 pounds each, and the mortar boxes are fitted with inside-plates and use coarse screens to secure rapid discharge. The battery tables are 11-feet long, with a step of about 2 inches every 17 inches, a metal plate being set across the table at each drop to throw the pulp down vertically on the head of the plate below. The slope of the tables can be regulated by means of adjusting screws.

From the plates the pulp is conveyed by launders, fitted with corrugated copper riffles, to six Watson & Denny grinding pans, standing on a floor 5 feet below the tables, which grind the pulp

to a finer size and their discharge passes to four Frue vanners on the next floor, which is 4 feet lower. The Frues yield concentrates containing 2 to 3 ounces of gold per ton, which are subsequently treated by cyaniding, whilst the Frue tailings pass through launders to four amalgamating pans, of the Wheeler class, which discharge into 8-feet diameter settlers set 3 feet below the pans; the refuse-slime from these latter going to settling pits, from which the clear water is pumped back into the battery storage-tanks.

The cyanide plant for treating the concentrates from the vanners consists of two solution tanks and two leaching vats, with zinc-boxes; the cost of cyanide treatment is stated* to be 8s. 9d. a ton. Mr. Bulman adds that actual figures over five months' working show an extraction of 90.8 per cent. of the gold contents. The average assay value of the ore milled (crushed chiefly for outside parties) was 2 ounces 3 dwt. 3 grs. per ton, and of the residual slimes, 3 dwts. 23 grs.; whilst the cost of milling (plate amalgamation, concentration, and pan amalgamation) ran from 14s. to 15s. a ton.

The Associated Mill:—This represents a type differing entirely from the two preceding ones, the oxidised ore being treated by dry-crushing and cyaniding. The stone from the mine is delivered to a rock-breaker at the top of the building, and thence into a sizing-trommel, which separates the fines from the coarse mill-rock. The fines are raised by a bucket elevator into a bin, and the coarse ore is delivered by automatic feeders to four Krupp ball mills, the product of which is raised by an elevator and joins the fines. The contents of the bin are discharged through canvas spouts into steel trucks (holding about 1 ton of crushed ore) which have W-shaped bottoms, the sides forming flap doors. Four or five of these tanks, placed end to end, are set on a carriage, drawn over the rails alongside the vats by an endless-rope, which can be started or stopped by a lever shifting the driving belt from a fast to a loose pulley.

The vats hold 160 tons, and it is claimed that by this arrangement the contents of the trucks are deposited more evenly over the area of the vats and no trimming is required. Two men fill a 160-ton vat in 8 to 10 hours. The residues are discharged through bottom doors into trucks below, and the charge is kept under cyanide treatment 10 days. During the year ending Aug. 1, 1898, it is stated that 20,519 tons of ore were treated in this mill, yielding 22,174 ounces, obtained at a cost of 18s. 2½d. a ton, of which 5s. 6d. a ton was chargeable to cyanide treatment.

* H. Bulman. Trans. Am. Inst. of Mining Engineers.

The Brown Hill Mill:—The new mill erected by this company, which was under construction when I saw it in February, 1898, like the mill last described, employs the same general methods, viz., dry crushing* and cyanide, to the treatment of the brown-stone, but applies it in quite a different manner. Broadly speaking, the process as explained to me by Dr. Pape (the able metallurgist in charge of its erection), was to consist in drying the ore after it left the stone-breakers and crushing it in Krupp ball mills, sizing it with air-separators (which, judging by the products I saw in the laboratory, effect this object most satisfactorily) the coarse classified products being cyanided separately in steel-vats in the ordinary way, and the slimes being treated by agitation and filter-pressing. A marked point of difference between the Associated and Brown Hill method of treatment is that in the latter mill bromo-cyanide is employed as a solvent, in place of ordinary cyanide.

AGITATION VATS, CYANIDE WORKS OF THE IVANHOE BATTERY.

By adding roasting-furnaces, it was expected that this plant could be adapted to the treatment either of oxidised ore or telluride, but for reasons hereafter mentioned, table-concentrators in addition may probably be required to deal satisfactorily with the richer grades of sulphide ore. The Company's crushings from October, 1898, to Sep-

* Mr. James Parke has pointed out that in dry-crushing ores in New Zealand, it is a curious and interesting circumstance that "the finer the dust, the higher its value," and the same thing has been remarked in dry crushing some of the Kalgoorlie ores.

tember, 1899, amounted to 42,025 tons, which yielded 87,762 ounces 3 dwts. 9 grs.

The Ivanhoe Battery, for a description of which I am indebted to Mr. Hewitson through the courtesy of the directors, contains 60 stamps driven by toothed gearing, provided with clutches for every 10 head. The ore is crushed in Gates crushers, and is delivered by an overhead tramway to the battery bins, from which it is fed to the stamps by Challenge feeders, the feeding stamp being No. 5. The ore is crushed through punched 16-mesh Russia-iron screens and the pulp passes over 12 feet of amalgamated copper-plates with a fall of ¾ inch to the foot, from which a distributing launder conveys it to canvas strakes, 50 feet in length, with a fall of 1½ inches per foot, which are swept down every hour with clean water. This keeps two men fully employed, and the concentrates collected, representing about 2 per cent. of the original ore, are stored and dried for subsequent treatment. The bulk of the mill-tailings is handled by a double 12-inch plunger tailings-pump. Mercury is added inside the mortar-boxes. The cost of mercury is reckoned at 2d. per ton milled.

The recovery by battery amalgamation in 1898 was estimated at 64.89 to 70.2 per cent. of the total gold, and in 1899, at 66.35 per cent. of the fine gold contents, 2.07 per cent. additional being recovered in the concentrates; the cost of milling in 1899, is officially stated to have been 5s. 0.836d. per ton of ore (4s. 3.85d. per ounce of bullion) calculated upon 59,604 tons milled, the costs being distributed as follows:—

1899.	Cost per Ton Milled. s. d.
Labour	1.7.338
Condensed Water	6.155
Salt Water	7.521
Tailings and Returning Water	4.388
Fuel	1.1.858
Quicksilver	1.213
Stores	0.919
Repairs and Renewals	7.444
	5s. 0.836d.

The treatment at these works on the whole closely resembles in principle that described at the Lake View.

The South Kalgurli battery is laid out on a somewhat different system, being designed to treat both oxidised and sulphide ores, which are kept separate in different bins, and pass first through a Gates crusher and then through Cornish rolls. Here the treatment of the two classes of ore diverges. The oxidised ore passes from the rolls

CYANIDE PLANT, NORTH BOULDER.

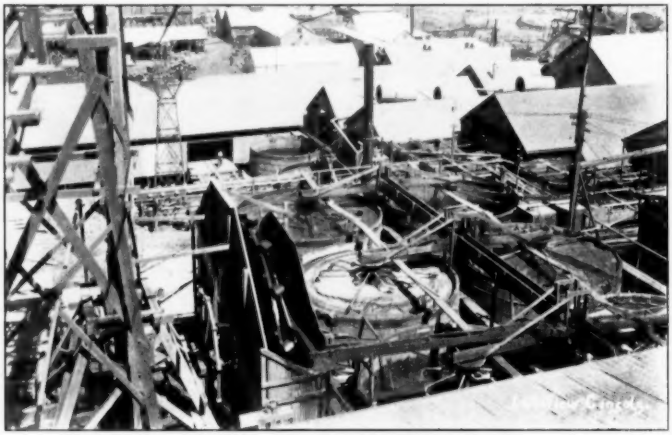
into wet-crushing Griffin mills, where part of the gold is recovered by amalgamation, and the pulp is afterwards run into grinding and amalgamating pans, completing this branch of the process. The sulphide ore, after leaving the Cornish rolls, passes through a rotatory drier and thence into dry-crushing Griffin mills, from which the ore is conveyed to a roasting furnace and de-sulphurised.

The Great Boulder Battery, for details of which I am indebted to Mr. Hamilton, through the courtesy of the Directors, contains thirty head of stamps, with copper-plate tables, six amalgamating and grinding pans, three settlers, and canvas concentrating tables; the system of treatment being somewhat similar to that described in use at the Lake View South. The stamps are in sets of five, and weigh 750 pounds. They are run at 80 drops per minute with an 8-inch fall, the order of drop being 1, 3, 5, 2, 4, and the capacity per head per diem 4.5 tons of oxidised ore. The mortars weigh 2 tons 5 cwt., and most of the gold is caught inside. The grinding-pans, employed to amalgamate the coarser particles of gold which escape the battery, are of the Watson-Denny type, and are run at 50 revolutions per minute and charged with two bottles of mercury each. The settlers which collect any amalgam or mercury that escapes from the pans are run at twenty-five revolutions per minute. The tailings pass over canvas-tables and are pumped into settling dams for collection and subsequent cyaniding. The loss of mercury is 0.425 to 0.470 ozs. per ton of ore milled.

The North Boulder battery building, besides the Huntington mills already described, contains an improved Blake stone-breaker, which

cubes the ore to 2 inches, the grizzlies being arranged to correspond; also, ore-bins, two Challenge feeders, and ten 950-pound stamps of Fraser & Chalmers pattern, run at 80 drops a minute, with a drop of 4 to 6 inches.

They put through on the average about 2 tons per head per diem under these conditions, but if the output of the mine had been on a larger scale, by increasing the speed to 85, and the drop to 8 inches, keeping the discharge low, and using coarser screens, their capacity could without doubt have been largely increased—probably, indeed, doubled. The explanation why, apart from other reasons, early advantage was not taken of this obvious means of cheapening the cost of milling, was the fact that with slower drops and high dis-



CYANIDE PLANT, LAKE VIEW CONSOLS.

charge a higher extraction was secured. This, before the company possessed cyanide works, was a matter for consideration when dealing with rich ore.

In 1898 the average yield of gold per ton milled was 19 dwts. 8 grs. and the average assay of tailings 7 dwts. 6 grs., showing an extraction by milling of 72.7 per cent., and as experiment has shown that about 16 per cent. of the gold remaining in the coarser sands is amalgamable, no doubt the extraction could be raised by amalgamation with finer crushing to between 80 and 85 per cent. of the total gold contents in the ore, but at the expense of a disproportionately increased cost. The following table shows the mill costs in detail in

1898 and 1899, when 10,150 tons and 9,772 tons were treated respectively:—

	1898, Cost per Ton of Ore Milled.			1899, Cost per Ton of Ore Milled.		
	s.	d.	per cent.	s.	d.	per cent.
Labour	3	8.510	43.61	3	7.000	36.91
Fuel	1	10.179	21.72	2	5.240	25.00
Water	1	11.777	23.27	2	2.830	22.94
Supplies.	d.			d.		
Screens	2.968			2.991		
Sub. oils	.465			.609		
Lighting oil				.715		
Mercury	1.740			1.253		
Chemicals	.375			.243		
Blankets	.391			.419		
Miscellaneous	1.999			.555		
		7.931	7.76		6.785	6.19
Tools		.153	.13		.505	.59
Repairs		3.570	3.49		10.490	8.97
	8s.	6.120d.	99.98	9s.	8.910d.	100.60

Milling 1,224 tons in October, 1899, the cost was, however, below these averages, viz., 7s. 9.82d. per ton, showing how largely the quantity milled affects the cost.

The Boulder Main Reef Battery contains a crusher and rock-bins, ten head of 950-pound Fraser & Chalmers stamps fed by automatic feeders, fitted with Blanton cams, and is furnished with blanket-tables for concentration.

For five months No. 1 battery worked with a front plate, whilst No. 2 battery was worked with both front and back plates in the mortar. Both batteries were furnished with lip plates. From the lip and back plates of No. 1 as much amalgam was obtained as from No. 2 battery. There was a marked improvement in the appearance of the lip plate of No. 1 battery without the front plate.

The amalgam obtained from No. 1 battery prior to the removal of the front plate on three occasions was from 1/10 to 1/15 more than from No. 2 battery. The distribution of the mill-costs shown in one month's run were as follows:—Mill, 3s. 8.6d.; steam, 4s. 6d.; water, 1s. 9.3d.; handling slimes, 1s. 4.1d. Total, 11s. 4d.

Tailings Treatment. Whilst the battery tailings vary considerably in value, it was found that it would, as a rule, pay handsomely to cyanide them; consequently most of the wet-crushing mills were early equipped with cyanide-plant for this purpose. The tailings not unfrequently contain some pyrites and a considerable quantity of black-sand, and carry up to 2½ per cent. or more of soluble salts—chloride of sodium and magnesium derived from the mill-water; hence

the addition of a small quantity of slaked lime to the mill launders conveying the tailings to the dams may sometimes be beneficial, and a preliminary wash of weak caustic soda say (0.1 per cent. strength) may diminish the consumption of cyanide; the extractor boxes are not, however, kept in as good condition in this latter way as by using lime.

Sometimes, as was the case in South Africa also, large heaps of battery tailings (sands and slimes) were accumulated in the early days, in which event they need to be trucked from the heaps to the cyanide-works; but most mills are now treating their raw or green tailings direct, as they come from the battery. In the dams where they still carry a lot of water after settling, they present a dirty, muddy, gray appearance, but when dried, the oxidised tailings, are, as a rule, of a red-brown colour.

Whether owing to some difference in the character of the ore, as I am inclined to think is the case, or partly at least in consequence of difference in the treatment it has previously undergone, it is a well-established fact that whilst in some cases the slimes in the battery-tailings are comparatively high-grade, in others they are so poor as not to be worth treating, and this has led to two different lines being pursued in dealing with them.

In the one case, as at the Great Boulder, the dry tailings from the settling dams are trucked to the cyanide plant, which has a capacity of 200 tons per 24 hours, and both sands and slimes, after being broken up in a disintegrator, are run into a sump, pumped into a vat with radial arms and agitated with cyanide in these agitation vats to dissolve the gold. When this is done, the pulp is discharged into a montejus and filter-pressed, and the solution is passed through the extractor-boxes, and returned to the sump. The cost of this treatment in 1899, dealing with 23,707 tons, is given as 11s. 9d. per ton, which produced 10,193 ounces of bullion, 850 fine, the loss in the residues being 39 grs. per ton, and the consumption of cyanide 2.2 pounds.

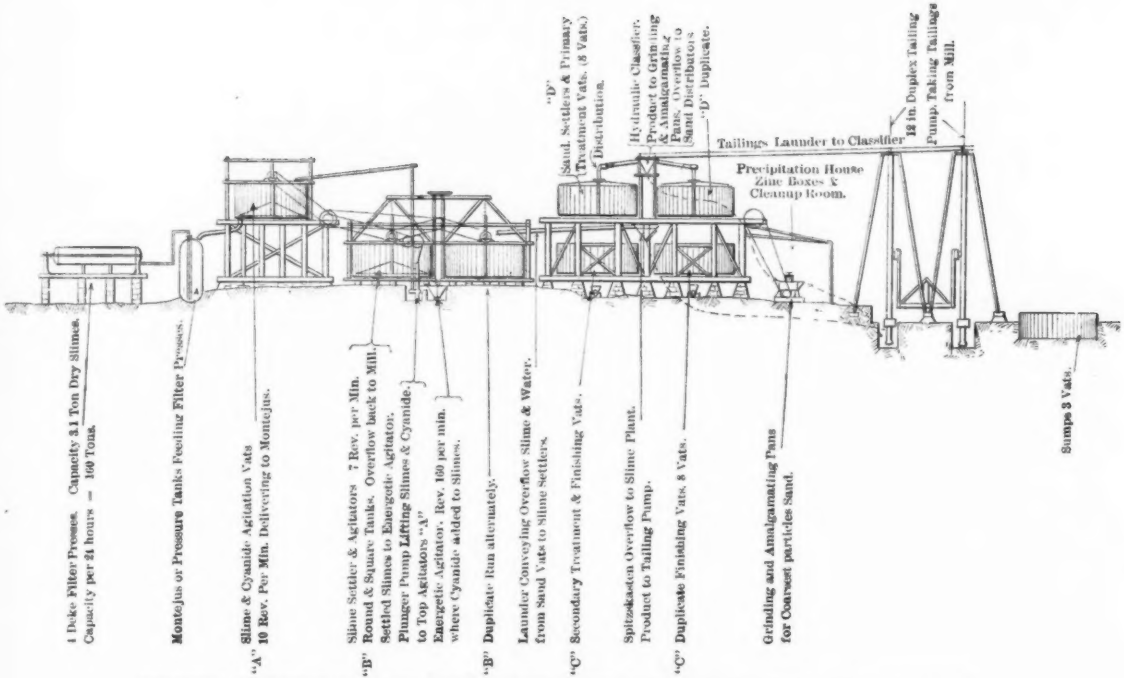
In the other case, as at Boulder Main Reef and North Boulder, the sands are separated from the slimes by settlement in one dam, and the slimes separated in a second dam, whilst the clear water flows to a sump, and is pumped back to be used over again. The sands thus collected are hauled to the cyanide plant, and treated by simple percolation, whilst the slimes may be regarded as worthless.

Handling the Battery-Tailings. Owing to the general flatness of the country, whether stored or treated direct the sands and slimes have usually to be elevated, and this is accomplished at the Great

Boulder Main Reef and North Boulder by means of tailings wheels, whilst at other plants, like the Ivanhoe, tailings pumps are used. The dams are formed of banks of dry-tailings, faced with sludge if the tailings are sandy, and are cheap to construct; but the arrangements for settling and clarifying the water are not, I think, generally carried to as high a pitch of perfection as in some other localities, notably Charters Towers, Queensland. The tailings wheels, a device familiar to old Freibergers, are, all, I believe, constructed with outside buckets; the one at the Great Boulder Main Reef (which I believe was the first one built in Western Australia) raises the tailings 18 feet. The German type, with inside buckets, has, however, several features to recommend it. The tailings-pumps, which are in common use for the same purpose, are able to lift the tailings to a much greater height than the tailings-wheels, and this is sometimes necessary. They are of the usual Australian pattern. I am not aware whether inclined Archimædian-screw centrifugal pumps have been tried for low lifts in this field, although they have been used, I know, for this purpose at Frieberg, at the New Central Aufbereitungs Works. Air-lifts, worked on the principle of the hydraulic elevator used in hydraulic mining, I am informed are employed on the Northern Goldfields, and there seems no reason why Pohle-pumps should not be employed.

The Treatment of Battery Tailings. At the Lake View the battery tailings, which contain about 80 per cent. of slimes, pass to a spitzkasten, the sands discharged from which are elevated by a tailings wheel to a set of six collecting tanks, with Butters' and Mein's distributors, which carry eight or more hollow radial arms, rotating in a horizontal plane above the tank on a central spindle. The stream of tailings delivered to them, falling into a cup-shaped receptacle, flows from the centre along the arms, and issuing at their ends, which are bent, causes them to rotate. The arms being of varying lengths (alternately long and short) the pulp is distributed evenly over the tank. The heavier sands which fall to the bottom still contain 40 to 50 per cent. of 100-mesh slime, and the lighter slimes escape through openings at the side which are closed by slats as the level of the contents of the tank rises. The sands are trucked to leaching vats in a separate building, at a lower level, where they undergo (according to Mr. H. F. Bulman) about 10 days' treatment, and the gold is precipitated on zinc shavings in the extractor-boxes. These contain a depth of about 16 inches of zinc, and are divided by transverse partitions into some ten consecutive compartments.

The slimes from the distributors, together with the slimes over-


1 Deike Filter Presses. Capacity 31 Ton Dry Slimes.
Capacity per 24 hours = 160 Tons.
Montejus or Pressure Tanks Feeding Filter Presses.
Slime & Cyanide Agitation Vats
"A" 10 Rev. Per Min. Delivering to Montejus.
Slime Settler & Agitators 7 Rev. per Min.
"B" Round & Square Tanks. Overflow back to Mill.
Settled Slimes to Energetic Agitator.
Plunger Pump Lifting Slimes & Cyanide
to Top Agitators "A"
Energetic Agitators. Rev. 100 per min.
where Cyanide added to Slimes.
"B" Duplicate Run alternately.
Launder Conveying Overflow Slime & Water
from Sand Vats to Slime Settlers.
"C" Secondary Treatment & Finishing Vats.
Spitzkasten Overflow to Slime Plant.
Product to Tailing Pump.
"C" Duplicate Finishing Vats. 8 Vats.
Grinding and Amalgamating Pans
for Coarsest particles Sand.
"D"
Sand Settlers & Primary
Treatment Vats. (8 Vats.)
Distribution.
Hydraulic Classifier.
Product to Grinding
& Amalgamating
Pans. Overflow to
Sand Distributors
"D" Duplicate.
Tailings Launder to Classifier
Precipitation House
Zinc Boxes &
Cleanup Room.
18 in. Duplex Tailing
Pump. Taking Tailings
from Mill.
Sumps 3 Vats.

SECTIONAL ELEVATION, SAND AND SLIMES CYANIDE PLANT, IVANHOE GOLD CORPORATION, KALGOORLIE.
Capacity of sand plant, 8-day treatment, 120 tons per day; of slimes plant, 160 tons per day.

flowing from the spitzkasten, are settled in settling-tanks, and are forced by compressed air by a couple of montejuses working under a pressure of 70 to 80 pounds per square inch into ten Dehne filter-presses. The cyanide leaching solution is pumped through the cakes of slime and subsequently washed with water. The process occupies about four hours.

At the Ivanhoe, the battery tailings are first lifted to spitzlutten, which separate the coarser sands. These are run into grinding and amalgamating pans, after which they are passed through spitzkasten, the overflowing pulp from which, together with that from the spitzlutten, goes to the cyanide-vats. The Ivanhoe plant consists of sixteen 80-ton vats, placed in two series directly above one another, the lower vats being set about 5 feet below the upper ones. The vats in upper series are provided with Butters' and Mein's distributors, and are used both as settling and leaching-tanks, the slimes which overflow through adjustable sluice-gates (representing, it is said, some 40 per cent. of the battery-tailings) going to the slimes plant.

The sands, after the vats have been filled to the required depth, are drained fairly dry and leached for four days in the upper series of vats, then dropped through bottom discharge doors to the lower series, again leached for four days, and finally dumped through bottom doors into trucks underneath, and trucked to the mine for filling.

It is claimed for this double-treatment that it shortens the time of leaching from ten days to eight, the tailings being oxygenated and loosened in passing the sands from one set of vats to the other. The solution leaving the vats runs by a separate pipe from each vat to distributing launders, built of Kauri pine, each 20 feet long by 2½ feet wide and 2¼ feet deep, which deliver it to a double set of zinc boxes. Mr. Bulman states that in October, 1898, 120 to 140 tons of sands were being treated daily in this plant, with a staff of 13 men; its average capacity is reckoned at about 120 tons.

The cost of treatment is given me as 5s. 6d. per ton, including cost of grinding and amalgamating the coarse sands in pans.

The Slimes Plant. The slimes and water from the upper series of cyanide vats are run to a series of slime settlers; after settling, the water is run off and the slimes are passed through agitators with cyanide solution, the length of agitation being about eight hours. The slime and solution is then forced by a montejus, under a pressure of about 45 pounds per square inch, into filter-presses of Dehne pattern.

There are four of these presses of the frame type, with 50 chambers in each, 40 inches square, forming cakes of slime two inches

thick. The slime thus collected, after leaching with solution, is washed with spent liquors whilst in the press, to displace any remaining gold solution, and this is again pumped through a smaller filter-press, containing 40 chambers 24 inches square, to clarify it before it passes to the precipitation department. The zinc boxes here consist of a double set, each being 20 feet long, 3½ feet wide, and 2¼ feet deep. The cakes in the filter-presses, after the gold has been dissolved out, are discharged into V-shaped side-tipping trucks, running underneath the presses, and are trucked to the waste dump.

The capacity of this slime-plant is 150 tons per diem, and the actual extraction of gold is, I am informed, from 80 to 90 per cent. of the gold contents. For cleaning up, sulphuric acid is used, and the gold is collected in a small clean-up filter-press.

The gold-slimes are melted in a tilting-furnace, in salamander retorts, 36 inches high by 23 inches wide, with a capacity of about 450 pounds weight of gold-slimes, and the whole clean-up (usually over 3,000 ounces) is melted and run into bars in about four hours.

The extraction calculated on the "fine gold" recovered by the Ivanhoe process, is estimated as follows:—

	1898.		1899.	
By Battery Amalgamation	68.3 per cent.	to	66.35 per cent.	
" Concentrates Treated	1.7 "		2.07 "	
" Cyanide Treatment	22.3 "	Sands	13.85 "	
		Slimes	8.46 "	
Total Extraction	92.3 per cent.		90.73 per cent.	

Value and Fineness of the Gold. Baron Oldruitenborgh states that the value of West Australian gold varies within broad limits. Gold produced from quartz veins, which is, as a rule, more or less argentiferous, is worth from £3.8 to £4.2 per ounce whilst the gold obtained from the formations has a value of £3.18 to £4.4 per ounce. The general average is about £3.15. Mr. Wm. Frecheville considers the average value of Kalgoorlie reef gold as being a little over £4 per ounce, but the bullion varies somewhat in fineness, depending on the method employed in its extraction.

LESSONS FROM THE EXPERIENCE OF BRITISH ORGANISED LABOUR.

By F. Brocklehurst.

THE ENGINEERING MAGAZINE has often and clearly expressed the belief that organisation, actuated by justice and common sense, is a movement of the utmost promise for promoting mutual comprehension and harmony between employers and employees. The tangibility, accessibility, and responsibility which association gives to otherwise indefinite and incoherent elements make it the very best medium for spreading knowledge, presenting argument, and inducing wise action. It is with sincere desire to aid the leaders of thought to the choice of aims which will succeed—away from efforts which will fail, because contrary to the genius of evolution—that this analysis of the record of Britain's great labour union is presented. Their own history furnishes the experimental demonstration most instructive to labour leaders everywhere—THE EDITORS.

THE concluding words of the Jubilee Souvenir of the Amalgamated Society of Engineers, which has been compiled by G. N. Barnes, the general secretary, run as follows:—"We have endeavoured in these pages to set out, without colouring or comment, a plain and unvarnished tale of the society's origin and subsequent proceedings, hoping and believing that its perusal will assist the members in making straight the paths leading to the society's greatest possible usefulness." It is much to be hoped that the members of the society will take to heart the suggestion thus conveyed, and that they will themselves add the "colouring and comment" necessary to make the Souvenir of real benefit to themselves and the whole engineering world. The little booklet published with the object just described is as much a serious warning as an encouragement, though probably little intended to play this dual *rôle*.

The Amalgamated Society of Engineers have certainly reason to be proud of the success which attended the efforts of the early pioneers towards unity in the engineering industry. Out of the scattered forces of trade unionism, they have welded together a federation second to none in the world; and their continued growth in numbers, in influence, and in financial value, can only be described as phenomenal. Honourable again is their association with the agitation which preceded the granting of the nine-hour day; and in the names of Allan, Newton, Rowlinson, Burnett, Gourlay, are represented successive movements each of which contributed to the prosperity and perman-

ence of their society. It is also to the credit of the association that it has continuously avoided the pitfalls which surround the question of co-operative workshops. Although a proposal to invest their surplus funds in this manner was recommended originally by the leaders of the society and popularised by an essay from the pen of Vansittart Neale, a full discussion of the question "killed it," though appearances of its resurrection afterwards are given in the Souvenir at recurring intervals. These are some of the things of which the engineers may be justly proud, but there is a contra account meriting special attention.

The record of the society's history bears traces of the struggles which frequently occur between rival trade unions over questions of demarcation of work. The subject is too well known to require extended treatment in this article. Sufficient only to point out that the danger of trade dislocation and loss from this source still remains, and that it is high time that authoritative boards were constituted by the societies interested to which all such questions could be referred for settlement. So far as can be gleaned from the Souvenir the society never appears to have taken a very strong line respecting non-union labour. In the latter part of 1896 seventy members struck work "against the employment of a non-union workman who had made himself obnoxious," but inasmuch as this action was determined upon without the prior knowledge of the executive committee, they were refused strike pay and advised to return to their machines. The trouble ended by the withdrawal of the workman objected to. A delegate meeting of that year passed a rule, however, which provided that "members should be entitled to contingent benefit if they left their work rather than work with non-society men." As is already well-known, the matter was finally settled at the close of the great engineering dispute in 1898 in the clause of the agreement which provides for "Freedom of employment." In returning to work under this the engineers bound themselves to acknowledge the freedom of the employers "to employ any man whether he belong or not to a trade union." Judging, however, from the history of the society as recorded in the pages of the "Souvenir," these have always been considered to be subsidiary questions. The greatest of the society's battles have been fought around the issues raised with respect to overtime, apprentices, piece-work, and control of machinery; and it is not without significance that, after struggles extending over half-a-century, the Amalgamated Society of Engineers has been compelled to acknowledge defeat with respect to every one of them.

One of the movements which directly contributed to the formation of the amalgamation had for its object "the curtailment of overtime and the reduction of hours in the London district." The first clause in the general pronouncement which issued from Birmingham in 1850 states: "We repudiate systematic overtime," and it threatens any member of the amalgamation refusing to comply with the then-declared policy with "liability to be excluded from the society." On submission to the members the vote against "systematic overtime" was carired by 5,709 to 16; but when the question was tested in battle with the employers, the latter, after a lock-out of several months' duration, gained the day. In the words of the Souvenir, "the dispute fizzled out." Forty-five years afterwards the Society recommended a set of regulations for overtime which had previously been acceded to by Messrs. Platt of Oldham. In these regulations provision is made for "systematic overtime" at the following rates of pay: "Time-and-a-quarter for the first two hours, time-and-a-half for the second, double time afterwards; and for pieceworkers an addition equal to the difference between overtime and ordinary rates." The settlement of 1898 recognised "systematic overtime" to the extent of no less than 40 hours per month, and "unrestricted overtime" in certain special cases.

If we turn to the question of apprentices we are met with a similar picture of a struggle resulting in ultimate and even more crushing defeat. The amalgamation adopted as its initial policy the restriction of apprentices "in proportion of one to four journeymen." The terms of the 1898 settlement declare that "there shall be no limitation to the number of apprentices," and the "note" is added that "this merely puts on record the existing practice." That is to say, the original policy of the society had to be abandoned as the result of practical experience. This result was not however achieved without some struggle. The Souvenir contains a record of a dispute which arose in Sunderland in 1883 respecting "the regulation of apprentices." The following is an exact copy of the concluding words in which the strike is described: "For the purpose mainly of this dispute, a levy of 3d. per week was maintained for a very considerable time, but the strike, notwithstanding, was a dismal failure, and tapered off to an unsatisfactory conclusion only when the men were dispersed elsewhere or absorbed in Sunderland under the old conditions, and after an expenditure of over £100,000."

The history of the disastrous opposition to the introduction of piecework can best be told in the words of the Jubilee Souvenir itself. The original rules of the amalgamation contained the following in-

junction: "That steps be taken to abolish piece-work." A vote of the members showed 5,297 against the practice, while only 18 were in its favour. This, together with the question of "systematic overtime" formed the officially recognised causes of the dispute of 1852, which, as we have already been informed, "fizzled out." At the delegate meeting of 1874 "a new rule was inserted laying down the conditions on which members could work by the piece," and this was afterwards remoulded in the delegate meeting of 1892. These concessions to the absolute necessities of the engineering industry did not, however, prevent members of the society undertaking strikes "against the introduction of piece-work." In 1875 a strike was conducted against piece-work at Erith "which dragged its weary length along to an unsatisfactory conclusion in May of the following year (1876)." And again: "The outstanding feature of the year 1890 was the strike against piece-work at the shops of the Maxim-Nordenfelt Company, at Erith, which began in November, 1899, and continued till September of the following year. In the abstract report issued just afterwards, the Council said: 'Not in the history of the society were ever arrangements so complete with a view to bringing a strike to a successful and rapid termination. Every member of the society, and those of the steam-engine makers, left. For the first time in a strike, all foremen were withdrawn, old and young, but without effect, as ultimately the strike was a failure in spite of liberal pecuniary support tendered from our trade fund and from voluntary subscriptions.' It should be here said," continues Mr. Barnes, "that this strike was also noticeable by the fact that the members of the Gas-Workers' Union had turned out in support of the engineers, and granted money towards the expense of the movement." The climax of the agitation was reached in 1898, when the society had to confess itself utterly beaten. The first line of the clause of the agreement relative to piece-work runs as follows: "The right to work piece-work at present exercised by many of the Federated employers shall be extended to all members of the Federation and to all their union workmen." Further comment is unnecessary.

The great struggle of the Amalgamated Society from the date of its formation down to the present time has been concerned with what is generally described as "the machine question." It is the one which occurs with greatest frequency in its history. The attempts of the engineers to control the machines have not, however, been crowned with success. With the exception of a partial triumph over Messrs. Hibbert, Platt & Sons, of Oldham, in 1851, the whole movement appears to have been a dire failure. The great lockout of 1852 origi-

nated primarily in a dispute with the Messrs. Hibbert & Platt, aforementioned. This firm, under pressure, it is said, assented to conditions of employment which embraced, *inter alia*, the following: "That in future the machines be worked either by mechanics or apprentices, to be taken up by them as they fall vacant," and "that the labourers be not unduly interfered with before Christmas, 1851, when the machines shall fall entirely into the hands of the mechanics, but if any of the labourers are discharged or the machines otherwise become vacant, the vacancies shall be filled up by the mechanics as they occur." This agreement was but of short duration, and in the following December the employers banded themselves together and determined to support Messrs. Platt by means of a sympathetic lockout if the demands of the engineers were persisted in. These, if we are to accept the statement put forward by the employers on this occasion, appear to have been as follows: "That all the men now working at planing machines be discharged and their places supplied by mechanics belonging to the trade union." This stringent policy of the Oldham men never seems to have met with the sympathy of the executive committee of the society, and they issued a note to the employers to the effect that they had neither "demanded the discharge of persons at present working self-acting machines, nor was it their intention to do so." "But," so the record runs, "all this was of no avail, and the society was held responsible both by employers and the public for the . . . claim in reference to machines." Although defeated on that occasion, the engineers' society has never yielded its claim to the control of self-acting machinery. Even at the present day it is one which is frequently urged by the delegates in the several districts with consequent friction and trouble. This is one of the questions, however, on which there appears to have been a continuously divided opinion between the rank and file of the members and the executive committee of the society. Coming as far down as 1897 we find that a strike took place at the Pallion Forge, Sunderland, against "horizontal boring lathes . . . being manipulated by handy men." A conference was held between the executives of the employers' federation and of the trade society, when the officials put forward the suggestion that "a mutually satisfactory solution of the difficulty is to be found in local committees, with a reference to the Board of Trade, such committees to decide—having due regard to class of machine, quality of work, and standard rate of district—upon the wage to be paid." These proposals were, however, rejected, and the machines were restarted on the lower rate, the men at the same time being induced by the council

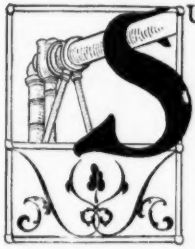
to remain at work. Several disturbances of a similar character broke out during the early summer of the same year; and in every one of them the members of the executive committee were against the men in their demand to make the differences a cause of industrial war. The London movement in favour of the eight-hour day intervened, and this was made the occasion of the great trade struggle which resulted so disastrously for the engineers' society in January, 1898. Under the head of "Selection, Training and Employment of Operatives" the terms of settlement contain the following clause: "Employers are responsible for the work turned out by their machine tools, and shall have full discretion to appoint the men they consider suitable to work them, and determine the conditions under which such machine tools shall be worked."

Such, in brief, is the history of the Amalgamated Society of Engineers in its relation to the questions of overtime, apprentices, piece-work, and the control of improved machinery. The experiences of the past fifty years will have been utterly wasted if the society continues a policy over which the word "Failure" is writ large. The apprenticeship question seldom, if ever, agitates the members of the society nowadays; while that of overtime is already provided for and, in the main, is accepted. Piece-work and the control of automatic machinery are the two burning issues, the fires of which have by no means been quenched by the agreement of 1898. A glance at the *Monthly Journal,* issued by the society, serves only to show that the engineers are still opposed to the introduction of the piece-work system, and that they are constantly setting themselves against the custom, which is evidently growing, of putting "handy-men" to watch automatic machinery. In a series of articles recently published in the *Manchester Evening News* (January 19, 26, Feb. 2, 9, 16), I have given reason to believe that in taking this course they are on lines which must inevitably land them in further disaster. At the risk of appearing to be unduly assertive, I venture to quote one or two sentences from those articles. They are as follows: "It is useless for us to blind ourselves to the fact that between the engineers and their employers another test either of strength or diplomacy is inevitable. . . . What are the engineers going to fight about? For the right to handle improved machinery? They have already lost this battle, and if they should ever be so ill-advised as to enter upon another conflict for the purpose of reversing the verdict of 1898, I venture to prophesy that they will be worse beaten than they were then. Time and science are against them. The only issue upon which they can win is the one of wages.

DISCREPANCIES OF PRECEPT IN MACHINE DESIGNING.

By Leicester Allen.

Not long since, allusion was made in these pages to the settled principles of machine designing which had been found to satisfy "all the conditions there are," and therefore were accepted in both theory and practice. Mr. Allen shows how far this status is from being universal.—THE EDITORS.



UBJECTIVE knowledge has been defined by an able logician and profound thinker as "the highest degree of certainty of which the mind is capable," and science as a system of classified knowledge and logical deductions from the facts included in classified knowledge. If knowledge be deficient, if strict lines of logical reasoning be not adhered to in deducing conclusions from orderly arrangement of facts, or, as sometimes happens, if deficient data are made the basis of illogical reasoning, we are at once led astray. Conclusions reached by mathematical methods, on account of the rigidity with which mathematics holds the reasoning faculties to lines of logic, are more readily accepted than those of pure deductive logic which excludes all ideas of quantitative relation.

The fact is, however, that two "ifs" always enter into mathematical reasoning. The conclusions finally arrived at are correct and reliable *if* the data upon which the operations proceed are really facts, and *if* no error has entered into the operations. To arrive at the highest degree of certainty the data must have been determined by methods, experimental or otherwise, such that the mind is compelled to accept them as true, and the mathematical operations must be scrutinized and tested till the mind is also forced to accept them as perfectly accurate. All element of doubt must be removed, for doubt does not, cannot, exist in any conclusion which can claim to be knowledge. If any residuum of doubt remains, conclusion sinks to the level of probability, or to the still lower level of possibility, and may fall still farther to mere guesswork. If a designer base his design upon average strength of material, how can he know that, in construction, a material of lower strength may not be employed, perhaps the most inferior of its kind? But if in the design a material of known strength and

quality be specified, and if the designer knows the strains to which this material will be subjected, he may, if competent, proceed with confidence and rely upon the adequacy of his work when done.

In mechanical engineering most of the data have been obtained from experimental investigations, and all designers, though they may be experimental investigators themselves, are obliged to accept the most of their data on authority. To satisfy themselves as to the reliability of facts determined by experiment and authoritatively stated, they usually examine the methods of performing experiments, and if these appear accurate, and the results are stated by experimenters accepted by the scientific world as competent to determine and state facts with equal accuracy, the results are not questioned, because the mode of experimenting and the reputation of the experimenter inspire implicit trust. The highest degree of certainty may inhere in the authoritative statements of results by renowned and skillful investigators and such statements may be accepted with so little reservation as to raise them above the level of mere probabilities. But when authorities of equal and high repute disagree, when the data and formulæ given by them do not attain uniformity, or even approach to uniformity, what is the designer to do? Shall he not only base his design upon average strength of material, but also take an average of the results of various formulæ, and from these formulate new rules and equations differing from some or all of those previously given? And, if he does this, can this in any sense be called a scientific method? And does not the widely differing practice of leading manufacturers show plainly that mechanical engineering, notwithstanding its great achievements and successes, has not yet reached a truly scientific plane?

Compare it for a moment with some other science—say chemistry. Chemistry, although, some differences of opinion yet remain upon theoretical points, is in its practical operations reduced to a substantial uniformity. Let one thousand chemists scattered in a dozen different countries essay to form a certain chemical compound, they would each take the same weight of the separate reagents necessary to form the given weight of compound, would put them together in the same manner, perform substantially the same manipulations, and each have at the end a product uniform in weight, physical and chemical qualities.

Suppose now that one hundred competent men were asked to design independently, a vertical, triple-expansion, condensing, pumping engine having piston valves for high-pressure and intermediate cylinders, with slide valve or valves for low-pressure cylinder; to take steam from boiler space in which pressure of 180 pounds is main-

tained; inducted steam to contain 10 per cent. of its weight of water; condenser pressure 4 pounds per square inch; piston stroke 72 inches; number of revolutions per minute to be 30; useful work to be 2,000 horse power; efficiency of engine to be not less than 85 per cent.; steam consumption per indicated horse power per hour not to exceed 12 pounds.

It will be noted that two of these specifications are elastic, the efficiency may be stretched upwards, the steam consumption downwards.

How many of the engines designed would exactly meet the specifications? How nearly would they look alike—how nearly weigh alike—how nearly cost alike if all were constructed by the same builder—how nearly work alike? Their proportions and weights would differ. Some would reach the required economy at one speed, some at another. Reaching the economy of steam consumption specified, some would fail in the stipulated efficiency of the engine. Each would be a law unto itself, but, in advance of trial, the law could not be precisely stated. The engines would no more be alike than a hundred different men selected from their general resemblance to each other. The most of them would be, scientifically considered, only coarse approximations to the stated requirements taken as a whole. And this would not be the fault of the designers. We shall, by roughly going over the progress of the work of designing, easily find the cause of their discrepancies.

In the first place, all the data relating to the properties of saturated and superheated steam the designer finds well-determined and conveniently tabulated; but, as he has to deal with neither one nor the other, but a mixture of steam with 10 per-cent. of water, this tabulated information does not apply directly to the case he has in hand. He would like to draw curves representing pressure and volume as a basis for computing mean effective pressures in the three cylinders, and in searching for a mode of doing this, he finds the exponential equations of Rankine, Grashof, and Zeuner, finds that the exponents differ, and finds that they do not represent the actual relations of pressure and volume in a steam cylinder of any available material. He finds that the adiabatic curve of pressure and volume is a still worse representative of what actually takes place in a steam cylinder, and further, that while a few determinations of curves obtained from steam mixed with stated percentages of water have been made, they have not all been made with such rigid care to eliminate error, and have not been repeated by different investigators sufficiently to establish them as scientific and reliable working data. So he draws the isothermal curve, knowing this also to be wrong, but different authorities state percentages of allow-

ance for error in using this curve. By making such an allowance he arrives at an assumed mean effective pressure from which he is able to deduce, with more or less inaccuracy, the diameters of the high-pressure cylinder and its co-operating cylinders which shall deliver under the stated conditions the expected horse power, after having first decided upon the matters of cylinder ratio, clearance, lead, and compression. On these four points he will again find plenty of conflict.

As to clearance and compression, most of those who will see this article will have already read Mr. Suplee's admirable summary of the present status of discussion and opinion on the subject, being the last article in the "Review of the Continental Press" in the April number of THE ENGINEERING MAGAZINE. Nothing could better illustrate the uncertainty which the opinions of this array of high authorities would create in the mind of the designer seeking light to guide him in his practical work. Doubtless the majority of the hundred designers selected would fall back upon the still prevalent doctrine that clearance, large or small, is a source of loss, the larger the clearance the greater the loss; and, having fixed upon the smallest practicable clearance, would next consider the cylinder ratio and points of cut-off. On the subject of cylinder ratio there is also a wide divergence of practice as well as theory. Seaton, an eminent authority, says:

"Like so many other matters in marine engineering, the questions of the best proportions and arrangements of cylinders are still open, and matters of opinion, and the most successful practice is that in which *the best compromise* between conflicting conditions has been effected. "The chief point at issue * * * * is the best ratio of cylinder capacity. * * * * There is necessity for exercising a considerable amount of discretion in fixing on the ratio." *

But when lead has to be considered, the designer finds himself still floating on his discretion without any guide, and in the hundred designs we shall find leads of from 5/16 inch down to no lead at all.

But, waiving further consideration of the uncertainties that beset the designers in their attempts to meet the requirements of the specifications as regards performance after the engines are built, let us pass on to parts wherein the theory of the engine has to be very little considered or not considered at all.

As to thickness of cylinder and liner, taking the formulæ of each of a dozen accepted authorities, he will get, for the same conditions of

* It is stated by Mr. H. H. Suplee (Trans. A. S. M. E. x 583) that an examination of fourteen quadruple-expansion engines working at an initial pressure of about 180 pounds per square inch discovered an average ratio of nearly 1, 2, 4, 8.

power, mean effective pressure, revolutions per minute, stroke, etc., a difference between the higher and lower result of over 92 per cent. of the lower. The thicknesses of cylinder heads will range from higher to lower through a difference of over 35 per cent. of the lower. Some of the authorities favor, while others object to, strengthening webs for cylinder heads. Following the same authorities he will find for piston heads a difference of thickness between the higher and lower result of over 122 per cent. of the lower. Computing for iron piston rods, from the higher to the lower diameter, he finds a difference of 75 per cent of the lower. Kent, in his Mechanical Engineer's Pocket Book, says: "There is perfect agreement among the authorities as to the formula for area of slides * * * * but the allowable pressure" (given by these authorities) "per square inch ranges all the way from 35 pounds to 500 pounds." There is greater uniformity in formulæ for connecting rods, but as the formulæ are given for different strokes and different lengths of connecting rods, it is observable that the formulæ of some authorities give larger diameters for short than for long stroke engines, while others give exactly the reverse. As to crank-pins, in the matter of their length, a difference of 33 per cent. of the length of the shorter is found in the longer as obtained by the formulæ. A difference of over 33 per cent. will be found in diameters. Very little discrepancy is found in formulæ for crank-arms. For fly-wheels a great variety of formulæ exist, and the variation in diameters and weights resulting from their use is material; but space enough has been absorbed in exhibiting discrepancies.

Kent, above quoted, sums up the whole matter as follows:

"The treatment of this subject" (dimensions of parts of engines) "by the leading authorities on the steam-engine is very unsatisfactory, being a confused mass of rules and formulæ based partly upon theory and partly upon practice. The practice of builders shows an exceeding diversity of opinion as to correct dimensions."

Our supposed designers then, in commencing their work, will plunge into a sea of uncertainty if they attempt to follow authority, unless they accept and blindly follow one sole authority. Some will assign average values to constants, and adopt formulæ which give an average of results obtained from the formulæ given by the authorities. The more experienced, however, will turn to their note books of former practice. These note books contain the records of the makeshifts and compromises by which they have been able to surmount, in some passable way, the difficulties and perplexities of past experience and form rules for individual guidance, whether these rules would be

acceptable to others or not. They have become self-reliant, and will follow no authority blindly nor accept implicitly from all the authorities anything that has not been confirmed by their own practical work.

But is this state of the art of mechanical design as indicated worthy the name of either knowledge or science, and is it not time in this twentieth century, that engineering and mechanical data should be sifted, classified, tested, the defective discarded and the good retained? Surely there must be some radical fault which leads to such a result as that two different designers should, for the same engine or same cylinder, fix upon sizes of piston rods of the same material one of which shall have 75 per cent. larger diameter than and weigh three times as much as the other.

I have simply selected the design of a steam engine as that which perhaps best illustrates a general fault in the entire field of machine designing, to wit, lack of exact data and uniformity of rules for computation. The fault is, I think, more pronounced in engine designing than in any other field, and so long as it is attempted to supply the want by independent discursive effort, the status will not be essentially different.

Mechanical engineers must agree to adopt a fixed factor of safety, prescribed by some authoritative source which will be universally accepted. They must cease to apply formulæ to materials of widely varying strength, as though all were equal in value for a specific constructive purpose. Why should a hard-and-fast rule be applied to determining dimensions of any part of an iron structure, without any knowledge of the test strength of the iron? No formula can be scientific in which an average strength is made an element. Given precise knowledge of the strength of the material used, and of the strains to which it will be subjected, the calculations of its dimensions, allowing a reasonable factor of safety upon which all might agree, would present no difficulties and involve no uncertainties. If it be said we do not know the strains, it may be replied that before mechanical enginering rises to the plane of science we must and shall know them. The present movement to establish a National Standardizing Bureau in the United States is a well-directed effort and should receive the support of every engineer and manufacturer. When established it should cooperate with similar bureaus already existing in European countries, and it is not too much to hope that ere many decades close, an international bureau fitted out for investigation in all branches of engineering shall supply tabulated data which, used in a uniform manner, will entitle mechanical engineering to be called a science as well as an art.

EDITORIAL COMMENT

THERE have been many remarkable strikes instituted at one time or another by labour organisations whose aggressiveness was larger than their wisdom or reason. In one recent American instance certain workmen struck to get themselves discharged. They were non-unionists, hired to fill out a force of union workmen, and when the unionists went on strike in protest against this engagement of outside labour, the non-organisation men who were the cause of the trouble enthusiastically walked out—"in sympathy."

The proposed strike of the British coal-miners against Sir Michael Hicks-Beach's export tax of a shilling per ton would have been scarcely less incredibly absurd. They have abandoned the intention for the present, according to statement, on the assurance that "the foreigner will pay the tax," but they will reconsider their agreement to work should this not be proved. The presumption is that if the foreign buyer will not pay the shilling, they would prefer that the foreign seller should capture the export market—for that would certainly be the result of a serious strike in the British coal mines. The likelihood of America's capturing a large share of the European coal business may not be as imminent as some have recently predicted; the fact that Britain held her own in the face of an advance of very many shillings a year ago indicates that one shilling is a wholly inconsiderable matter; but with Britain's output cut off, her customers would be compelled to make new arrangements, and once sent "over the way" would never again reopen dealings on the former scale.

* * *

THE ENGINEERING MAGAZINE was the first to preach the universal importance of industrial matters, and to demonstrate the wonderful responsive interest in the intelligent and authoritative presentation of the facts of engineering progress and the study of the best methods and management. It has been a leading influence in the reorganisation of productive industry necessitated by the wonderful expansion of the last decade—in awakening the leaders of industry and its commercial and financial copartners to the necessity of extending their observation to an international range, and of improving their practice by the adoption of the best methods anywhere discoverable. And this influence is reflected throughout the periodical press, popular as well as technical. Even the "literary magazines" have discovered the general demand for information on subjects which at one time they would have considered wholly technical, and left for treatment by the engineering press in a wholly technical manner addressed solely to the specialist, and often incomprehensible even to the engineer in a closely affiliated line. The fact that many of the subjects were of vital importance to every one concerned in material progress—which means practically all civilisation—and should be clearly presented in plain language comprehensible to every intelligent understanding, remained to be demonstrated by the remarkable success of this effort.

An examination of the files of any of the magazines in the literary field will reveal a large and increasing number of articles devoted to subjects at least semi-technical in character. The tendency is admirable, but unfortunately the treatment too often lacks the most desirable element of accuracy. If an article sounds "learned" it is passed by the editor with an implicit acceptance which he would not think of extending to cover statements in history,

biography, or letters. It would seem that if the thing were worth doing, it was worth doing well, but too often it is so done that it provokes amusement—or some less kindly feeling—from those who should be most interested and appreciative. Even so ably and admirably conducted a magazine as the *World's Work*, in an article on the long-distance transmission of electrical power, speaks of "getting 10,000 volts from the Big Cottonwood," "adding 16,000 volts to the available supply," "sending 10,000 volts into London" or the Rhine "yielding 16,500 volts at Rheinfelden," as if the volt were a unit of power instead of a unit of pressure. In fact, this seems to be the confusion existing in the author's mind, for the Rheinfelden plant develops 16,000 horse power, which is transmitted by a current of 6,800 volts and 80 amperes.

The point is not merely captious. Such papers, if correct, are widely educational. If not worth the pains necessary to make them correct, they would at least be better for the omission of expressions which are meaningless to the layman and, as thus incorrectly used, uninstructive and absurd to the professional.

* * *

Trust formation, which for some months in the United States had experienced a period of comparative quiet, has been started into new fermentation by the launching of the United States Steel Corporation. The air is full of announcements and rumors of consolidations. Not content with home worlds, the magnates are going abroad to conquer England and the Continent, and all the world is to be one great combine. There is to be no place any more for competition, according to the promoters, and yet under their very shadow competitive concerns are starting up. It is painfully hard to eliminate one of the elemental principles of life, and what kind of a state would remain if this one could be eliminated? Something less than life as it has always been known.

Hasty advisers have clamoured for British iron masters to meet the trust by counter-combination; it is indubitable, however that their present unfavourable position is due, as averred by Mr. Garrett at the recent meeting of the Iron and Steel Institute, to too little competition in the past. The shock of the sudden awakening they have just experienced may be the beginning of their salvation. It is by rivalling the United States in the fearless pursuit of economic methods, the study of intensified production, and the adoption of improved machinery, however, that they will rise to new industrial ascendancy—not by venturing in the untested and dubious pathway of "regulation instead of competition"; by following the example set in the past by Carnegie, not the dazzling but unproved prospectus held forth by Morgan.

* * *

The interesting and widely read articles on Russia, which appeared in this Magazine in February, March, and April, will be resumed in July after an unavoidable interruption caused by the pressure of Mr. Ford's business engagements. The concluding article will deal particularly with Russia as a market for machinery and especially machine tools. It will actually gain in effectiveness by the postponement as Mr. Ford has been enabled to study and determine with reasonable definiteness the actual effect of the tariff reprisal measures directed by M. Witte against the United States, under the provocation of Secretary Gage's imposition of "countervailing duties" on Russian beet sugar going to America. While Mr. Ford is a firm believer in the mutual profit and splendid future of Russo-American trade relations, and does not believe the amount of American export manufactures finding their way to Russia will be very greatly diminished by the "tiff," he indicates that the immediate relations heretofore existing will give way for the present to indirection and "underground" methods which will certainly be to the disadvantage of the United States manufacturer and will play into the hands of his English and German competitor. The paper will be the most interesting of the group.

REVIEW OF THE BRITISH PRESS

Modern Artillery.

A very interesting paper on "Modern Artillery," by Lieut. Arthur Trevor Dawson, appears in the *Journal of the Society of Arts*. While limited by its author's preface to a comparative examination of certain types of ordnance, British and foreign, with a view to examining specific differences and relative advantages, it affords a remarkable demonstration of the extent to which military engineering has drawn upon the civil branches of the profession for its recent advance. Modern artillery owes the greater part of its efficiency and accuracy to the genius of the mechanical engineer. Hydraulic, pneumatic and electric appliances bring the ammunition to the modern large gun, load, lay and train the piece, and take up the recoil. The improvement of mining practice has furnished valuable help in the search for low-temperature and high-power explosives; the metallurgist has contributed the materials necessary to meet the difficult requirements; and all this aside from the admirable mechanical skill developed in the design and construction of the ordnance and its auxiliaries.

The resultant is that, as in every other use of mechanical construction, the type of a very few years ago is obsolete, and the old so hopelessly inferior to the new that its retention means loss of supremacy. Lieut. Dawson points out that even the Inflexible, heading the list of Royal Navy vessels armed with muzzle loaders, with her 485 men, if opposed to a French cruiser of the Cassard class, with but 385 in her crew, but with modern guns and telescopic sights, would be helpless at 8,000 yards or beyond. Yet at this range the French ship "would be able to make good practice," and in the Lieutenant's opinion would put the British ship quickly out of action. This affords excellent reason for either selling the old ships or giving them modern armament, and Lieut. Dawson favours the latter course, believing they would be of value in the reserve. He advocates that every vessel of British registry over 3,000 tons and 17-knots speed "should be called upon to have suitable deck attachments for the accommodation of 6-inch quick-firing guns," believing strongly in the efficacy of the unarmoured ship of great speed and high gun power, which can control her range.

First in importance of the factors in the improvements of modern artillery Lieut. Dawson places the propelling agent—powder. The initiation of modern explosives has made it possible to more than treble the energies of guns as compared with the days of black powder. Secondly, their smokelessness has rendered great rapidity of fire possible, the object aimed at being practically visible at all times. Great Britain, in the Lieutenant's opinion, has not realised the utmost possibilities of advance in this direction, using cordite containing about 57 per cent. nitroglycerine instead of the nitro-cellulose powders adopted generally by the United States, Russia, France, and lately Germany. He admits that at the time of its adoption, cordite was the best explosive known, and that the experiences of other countries with nitro-cellulose powders were not for some time entirely satisfactory; but the manufacture of these powders is now much improved; they are entirely safe, stable in all climates, and under all service conditions, and at present alone "capable of producing in modern artillery the highest possible ballistics with the least possible amount of wear to the gun." The high temperature of explosion of cordite—far exceeding the melting point of steel—makes it unreasonable to expect a gun in which it is used to stand many rounds. Further, if cordite is used, "no higher velocity than, say, about 2,500 feet can be obtained for any reasonable number of rounds, whereas with nitro-cellulose powder, velocities up to and exceeding 3,000 feet can be easily obtained." The difference in military effectiveness is shown by a "dangerous-space"

diagram. At a range of 2,500 yards, with an initial velocity of 1,882 foot seconds, the dangerous zone is but 162 yards in width; with a muzzle velocity of 2,160 foot seconds, it widens to 226 yards, while with a muzzle velocity of 3,000 foot seconds the very flat trajectory of the shell extends the danger zone for the attacked vessel to 465 yards in width.

A very interesting section of Lieut. Dawson's paper is devoted to the modern accurate gun sights, and one to shrapnell fuzes; a considerable portion of it is taken up with quick-firing field guns, field howitzers, mountain guns, and automatic arms, large and small. We must perforce content ourselves with passing to his concluding references to the mounting and arrangement of heavy sea-service guns, and especially the superposed turrets of the U. S. S. Kearsarge and Kentucky, which have lately excited so much discussion. In contrast with these he places an arrangement of two 12-inch guns, mounted on Vickers' system.

"This is quite a novel type of mounting, admitting of the loading of the gun at any angle of elevation as well as at any angle of training, so that during the operation of loading the gun layer is able to accurately sight the two guns, and thus immediately the one or both are loaded they can be fired. Arrangements are made that a supply of ammunition is continually being supplied through the ammunition trunk, so that the cage, which travels on the arc concentric with the trunnion of the gun, is always kept filled, and thus immediately the gun is fired the cage can be raised to the loading position, ready for a new charge.

"The system lends itself well to the general quick-loading principles applied to the heaviest types of ordnance. Two rounds per minute from each gun can easily be obtained in actual practice. Five British first-class battle-ships now building are being fitted with these mountings, making their heaviest guns really quick-firers.

"I next come to two special mountings of American type, and I will first refer to that being installed in the Alabama class for mounting their 13-inch guns. The great feature of the mounting is that only electric power is used, with the exception of the recoil arrangements, which are hydraulic in combination with heavy springs for running the gun out. The rammer is worked by hand power, and the ammunition cage lifted by electrical power. This mounting only admits of loading at a fixed angle, and is necessarily very heavy, owing to the springs required for running the gun out in combination with the heavy cradle necessary for the carrying out of this system. They do not claim to fire more than one round in two minutes from each of these guns so mounted, as against four which will be obtained from the British mounting."

Concerning the superimposed-turret arrangement of the Kearsarge and Kentucky, Lieut. Dawson says: "I am told that the arrangement has been successful from an artillery point of view, but it would strike me as being exceedingly heavy and dangerous because if one turret is put out of action it means that four of the principal guns of the ship are *hors de combat*." It will be noticed that in the matter of gun-mountings, on their modern ships at least, the Lieutenant believes the Admiralty are to be congratulated.

The Large Gas Engine.

THERE are two principal ways in which the economy of production is continually being bettered; one, the improvement of the functional efficiency of existing media, the other, the utilisation of former waste. The large gas engine, as applied particularly to the use of blast-furnace gases, serves most strikingly in both capacities and thereby promises to be one of the most salient features in the advance of power engineering during the 20th century. It was ably reviewed in these pages last December by Mr. Bryan Donkin; the *Electrical Review* (London) contains some notes of a visit to Seraing, by Mr. E. Kilburn Scott, A. M. Inst. C. E., which are of additional and yet more recent interest.

The 1,000-horse-power engine, which was the largest mentioned by Mr. Donkin as having been undertaken up to the summer of 1900 is already left behind. Three Delamere-Debouteville-Cockerill gas engines of 1,200 horse power each are on order "for a Lorraine iron works, the furnaces of which have a daily output of 300 tons of pig iron. Designs are also completed for a 2500-horse-power size, and it will probably be put in hand shortly." In fact, Mr. Scott remarks

that the work he saw at the Cockerill establishment "could certainly only be effectively carried out by the very largest engine-making firms. In Germany alone three firms have taken out licenses from the Cockerill company * * * and altogether they and their licensees have about eighty engines of 500 horse power and over on order at the present time."

The gain is not confined to the utilisation of so much power formerly thrown away, nor even to the improvement indicated by the gas engines' thermal efficiency of 30 per cent., as against the 6 per cent. of ordinary steam-engine and boiler practice. There is another consideration yet. Mr. Scott quotes M. Adolphe Greiner, director-general of the Cockerill company, as saying:

"There are some works which could not have been established if the invention had not been brought into effect. I may mention the blast furnaces at Toula, in the neighbourhood of Moscow, in a situation where water is entirely absent, and a still larger works in the island of Elba under identical circumstances. The furnaces in this island, where fresh water is non-existent, will require three 600-horse-power blowing engines and three gas motors for electric plant of 200 horse power each."

The paper concludes with a particular reference to the adaptation of the gas-engine to the work of an electric station—a use to which, as Mr. Scott points out in his introduction, English engineers had declared it was quite unsuited, certainly at least in sizes larger than 40 or 50 horse power.

"Whilst Messrs. Cockerill prefer to make the single-crank engine, they also build them two-crank (as in a cross-compound engine) the alternator or dynamo being carried direct on the engine crankshaft. As it happens, the latest type of alternator, in which the poles are bolted on to the inner periphery of the fly-wheel, enables the rim of the latter to be made of great weight without any trouble, and this and the use of heavy copper bands round or through the pole faces (amortisseurs) should go a long way towards doing away with any difficulty in running alternators in parallel. Of course, for electrical work the gas is mixed, and fires at every fourth stroke, whatever the load. It is only for blowing purposes where regulation of speed is quite unimportant that the old-fashioned hit-and-miss idea is employed.

"The only trouble Messrs. Cockerill have had with the engines has been in a particular case where the blast furnace gas carried over a good deal of gritty dust. At Seraing the gas comes away comparatively clean, so that there is no trouble, but in any case when excessive dust does occur, it only means that a little more care must be taken in cleaning the gas before admitting it to the engine. For an electric power station there would be no question of dust or tar in the gas. Either the Mond process as employed at Winnington, the producer method of Mr. Thompson, Glasgow, the Duff process (Granite City Steel Company's Works, Illinois), or some similar process would be used to abstract the ammonia and other bye-products, and so the full value of the coal would be made use of instead of it being wasted in boiler furnaces. Of course, it is only when dealing with very large plants that it pays to put down the apparatus required to remove sulphate of ammonia, etc.

"When considered for the purpose of supplying power for electric transmission stations the details of the producer are almost as important as those of the engine: in fact, one of the reasons why in some cases unsatisfactory results have been attained with gas producers, has been because the attendance on a producer is such an unpleasant job that the fuel has not been fed regularly. It is quite important that the feed should be taken out of the hands of the attendants as much as possible."

The New White Star Liner Celtic.

ABOUT three years ago, Mr. E. L. Corthell plotted a very interesting curve of the progress in naval architecture for some decades back, as represented by averages and maxima of dimensions and tonnage of steam vessels. Extending it for another quarter century, it indicated that the largest steamers of that time would have a length approximating 1,000 feet, with other dimensions in proportion. The least flexible limitation, of course, was found in the insufficient depth of some of the greatest harbours of the world, but the civil engineer is constantly working parallel to the increasing demands upon the ship-builder and probably will have his task completed in good season.

Several notable steps have been taken in rapid succession during the past five years. The great cargo carrier Pennsylvania was followed by the Oceanic, still the longest vessel afloat; the speed record was captured by the Deutschland; now the leading place in gross tonnage and displacement is taken by the Celtic, like the Oceanic a White Star liner and a product of the yards of Harland & Wolff at Belfast. Until the Wilhelm der Zweite, now building, is launched at Stettin, the Celtic is entitled to honour as the largest ship afloat.

Some interesting particulars concerning the vessel are given in *Engineering* in an article from which the following paragraphs are quoted:

"The dimensions of the Celtic are: Length, 698 ft. 8 in.; breadth, 75 ft. 4½ in.; depth moulded, 49 ft.; with a total gross tonnage of 20,880, while the displacement at 36 ft. 6 in. is expected to be 37,700 tons. This, of course, includes cargo, but some idea of the immense weight involved in the vessel herself may be formed from the fact that her launching displacement was 14,259 tons upon a draught forward of 15 ft. 4 in. and aft of 17 ft. 2 in., giving an average of 16 ft. 3 in. This is the heaviest displacement of any ship launched, considerably exceeding that of the Oceanic.

"The Celtic represents a distinctly interesting type, which promises a large financial reward; for, with her speed of from 16 to 16½ knots, her coal bill will be very much less than that of many of her competitors on the Atlantic, while, at the same time, she is certainly not deficient in any of the comforts provided on the faster ships. She carries a very much larger number of passengers in the steerage, although fewer first and second than in some of the other ships, her total of first-class passengers being 347, of the second-class 160, while in the steerage she takes 2,352.

"The main propelling engines of the Celtic are of the quadruple-expansion type, balanced so as to minimise vibration. There are four cylinders, the diameters respectively being 33 in., 47½ in., 68½ in., and 98 in., the stroke being 5 ft. 3 in. The cylinders work on four cranks, the arrangement of cylinders and valves from the forward end being as follows: High pressure, with next its piston valve, then the second intermediate with its piston valve, a double-ported slide valve with a balance piston on the top for the low pressure, which comes next, then the first intermediate cylinder, with, finally, its piston valve. The arrangement of valves thus differs slightly from that in the Yarrow-Schlick-Tweedy system in respect that the high-pressure valve is between the high-pressure cylinder and the second intermediate, instead of being at the forward end; but the "centres" of the high-pressure and second intermediate cylinders are about the same as the distance apart of the other two cylinders of the engine. Each cylinder is a separate casting, supported in front on the A frame; while at the back there is a condenser incorporated into the framing of the low-pressure and first intermediate cylinders. The working parts are entirely of steel, and the connecting rods are 11 ft. 9½ in. long between centres. The diameter of the crankshaft is 19¼ in., the pins being 20 in. The tunnel shaft is 18 in. in diameter, the propeller shaft is 19½ in., and the propellers, which are three-bladed, are 20 ft. in diameter. The air, bilge, and sanitary pumps are worked by levers from the crossheads, but the centrifugal pumps are operated by separate engines. The cooling surface in each condenser is 9,000 square feet. Weir system of feed pumps is used for the main and auxiliary feed to the boiler. There are eight double-ended boilers working at a pressure of 210 lb. per square inch. The boilers are 19 ft. 6 in. by 15 ft. 9 in., the total heating surface being 41,680 square feet, and the grate area 1,014 square feet. The height of the funnels is 120 ft. above the grate area. The vessel is expected to develop a speed of 16½ knots when these engines are working at 14,000 indicated horsepower, and to most travellers on a comfortably and well appointed ship, able to withstand the heavy seas, this speed will be quite satisfactory."

Australasian Iron Resources.

In view of the general anxiety lest the world's iron resources should, within a calculable time, prove inadequate to the cumulative requirements—an anxiety set forth by Mr. J. S. Jeans in this Magazine for July, 1900, and especially in view of the menace of a large portion of the more desirable ores coming under sole control

of a huge combination, the examination of British colonial iron-ore deposits has received sudden stimulation. The brilliant possibilities of Canada and Newfoundland will form the subject of an illustrated article in an early issue of THE ENGINEERING MAGAZINE, and this will shortly be followed by an interesting review of "Iron making in Australia." Meantime a general summary of the outlook for iron manufacture in Australasia, in *The Iron and Coal Trades Review,* is worthy of comment.

So far the production has not been impressive. New South Wales occupies the largest space in the review. "There are important deposits of rich iron ore suitable for smelting purposes at Marulan, Goulburn, Bredalbane, Carcoar, Rylston, Mittagong, Wallerawang, and other districts." The last three are "roughly estimated to contain 12,944,000 tons of ores, containing 5,853,000 tons of metallic iron." The Carcoar deposits are estimated at 2,571,000 tons, consisting of "an intimate mixture of limonite and hematite." Picked samples of the hematite showed 0.113 and 0.307 per cent. of phosphorus, and it is stated that "by exercising a little more care" an ore could be supplied yielding about 50 per cent. metallic iron; but shipments have been on a guarantee of over 45 per cent., later reduced to 43 per cent., and the phosphorus in bulk samples from the quarry face have run up to 0.709 per cent. phosphorus. "There are abundant supplies of coal, which can be delivered at the pit's mouth for less than 4s. per ton, the climate is good, and there is an unlimited supply of good water, and limestone can be obtained at Portland, which is distant by railway only 17 miles." Ore shipments for three years aggregate 17,000 tons. The cost of iron making is estimated at £2. 7. 7, against £2. 12. 1 at Middlesbrough, and £1. 11. 5 at Pittsburgh. The Government has been vainly urged to establish iron works, but private concerns have proposed the erection of iron works at Port Kembla at an expenditure of half-a-million sterling.

In Victoria, an iron mine existed more than twenty years ago on the Western Moorarbool River, near the Ballarat gold fields. An offer by the Minister of Mines of a bounty of £10,000 for the first 5,000 tons of iron has never been claimed; a company seeking it discontinued operations after making 500 tons. The Federal company acquired the property and is erecting smelting works at Geelong. The ore seems to have been imperfectly examined; it is reported to run from 32 per cent. to 84 per cent. oxide of iron, the latter being at a depth of 16 to 19 feet. One lease alone is estimated to be sufficient to keep two 100-ton-per-week furnaces running for 50 years, with an estimated cost per ton of iron of £2. 10 to £3. 10 according to quality. New Zealand has the Taranaki iron sands, and the Minister of Mines has said that the Government is disposed to consider favourably a proposal to grant a bonus of £1 per ton, on the first 24,000 tons of iron or steel produced, to a company with a capital of not less than £200,000, of which £100,000 shall be spent in acquiring lands and erecting plant. It is reported that "several companies are being formed in London to manufacture steel direct from this valuable and extensive deposit."

Tasmania centers its interest, so far as iron making is concerned, in the Blythe iron mine, near Burnie, worked by an English company with a capital of £1,000,000. A narrow-gauge railway is to carry the ore "to the wharves at Burnie, there to be shipped to the other colonies and perhaps to wider markets." It is estimated that there are 40,000,000 tons of ore above water level, but the quantity produced in the first half of 1897 was 987 tons.

The South Australian Government has a standing offer of a bonus of £2,000 for the first 500 tons of pig iron produced in the colony, but it is still unclaimed.

The local demand is measured by a summary of the imports of iron, machinery, and iron manufactures into the colonies of New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, and New Zealand for three years. The aggregate was £6,840,776 in 1896, £8,713,017 in 1897, and £8,681,451 in 1898. The *Review* characterises this very fairly as "a market of first importance," but its satisfaction means the establishment of very much more than iron furnaces. Iron and coal constitute the basis of all large industries, and the Australian colonies have a fair foundation from which to start the growth of their industrial structure.

The British Iron Trade and Its Rivals.

THE spectacular entrance made by the huge American trust has concentrated attention upon the iron and steel industry and called forth a deluge of comment upon the position and prospects of the British iron master. Some of the commentators are blindly confident—some deeply pessimistic—some, like Mr. Phillips in our pages this month and last, wisely analytical in pushing the examination to completeness, even if the process is painful.

The *Iron and Coal Trades Review* takes the title above for a leading editorial, which contains some suggestions not generally heard heretofore. At the outset the point is made that the public attention is so largely occupied with the iron trade not only because that trade is so very important *per se*, but also "because the same principles and conditions that affect one British industry are likely, *mutatis mutandis*, to apply to many others. * * * If Protection enables the protected country to sell dear at home in order that it may sell cheap abroad, if free trade in railways ensures cheap transport, if mechanical ingenuity and unquenchable enterprise bring about the most economical methods and processes, if powerful syndicates obtain and retain the control of price and production, if unique natural resources place the nation that owns them at an enormous advantage, then these considerations apply as much to any one industry as to any other. Hence, if the Americans are likely to vanquish us in the iron trade, one naturally asks: What about the cotton, the woollen, the leather, the paper-making, the sugar, and other important industries? The real truth is that every one of these, and many others, are more or less threatened; but we have heard an unusual number of statements and rumours about the iron trade, because the conditions affecting that trade are more directly in evidence, and because it is the basis of so many other industries in which material progress is involved."

The *Review* finds much that is encouraging in the attitude of British industrial managers—foremost that immediate determination to place themselves by every means in the forefront to which we have more than once referred in these pages.

"It is, therefore, of vital importance to note that the members of the British iron trade appear at last to be completely alive to the dangers that assail them, and to the necessity that exists for seeking to put their house in order. This process is being attempted or pursued in many different ways. Perhaps the most important of all is the new-born enterprise that has been developed in adopting up-to-date processes and plant. Most of the leading establishments and companies concerned in the iron trade are either introducing economies or seeking for them. The British Iron Trade Association has recently had under consideration the question of how far a full and exhaustive enquiry should be made into the causes and conditions affecting the success of foreign competion. Most of the leading firms in the United Kingdom have either already sent, or are now sending, experts to the United States in order to see 'how to do it,' and the lessons of American experience are now being applied at home to an extent that was never visible before. A larger amount of attention is being given to the most profitable and useful systems of commercial and technical education so as to have our rising generation better equipped for the race than hitherto. There has even been a good deal of talk as to syndicating, on American lines, the tinplate and other special branches of the iron trade. The keenest interest is being taken in the subject of extending and cheapening our supplies of raw materials, and the latest movement in this direction has been the much-talked-of development of the iron-ore fields of Dunderland, in Norway, by the Edison Ore-Milling Syndicate, whereby vast quantities of material are likely to be placed at the disposal of the British iron industry. All this, and much more, makes for improvement, and encourages the hope that the British iron industry may be able, after all, to show a good fight." We should go most of the way with the editor of the *Review* in his conclusion that these things are encouraging for the British iron industry, but we should have to leave him just this side of the Dunderland project. We do not see much encouragement for the British iron trade in that. The *Review* concludes, however, with the rather surprising statement that the British iron trade is "handicapped, and, probably, may continue to be so by two fundamental conditions:

The first, the limitations placed on the command of capital within the iron trade itself; and the second the natural disinclination of capitalists not in the trade to embark in a business that is so notoriously uncertain and precarious. We use the words 'natural disinclination' because the iron trade has never been regarded as one of the safest investments, and, because, in face of the much-talked-of competition of other countries, and the very palpable demonstrations of its success, the future of the British iron trade appears to be more uncertain than ever." The British iron industry has been accused of apathy, overconfidence, overconservatism, dangerous indifference to competition, inability to get out or even see out of a rut, superannuation, and many other failings; but the imputation of poverty seems new. The *Review* however fortifies the statement with corroborative evidence that capital has been slow to engage in the iron industry:

"It is a remarkable fact that no new iron or steel works of any importance have been constructed in this country for a long period. We believe that the last new British ironworks were built so far back as 1890, or practically eleven years ago. In the interval, Germany and the United States have constructed many new establishments, and made important additions to many more. This naturally gives to those countries the command of more efficient and economical plants than we possess in Great Britain. Every practical ironmaster and steel manufacturer knows that a completely up-to-date plant, erected in a suitable locality, under sound and honest conditions, would be likely to make easier and larger profits than most of the older plants with which it would have to compete. A large number of those older plants, to begin with, are greatly overcapitalised, and in a good many cases their inflated capital represents very little more than scrap values. All this should be altered with a plant on the most modern conditions."

Perhaps if English iron masters had been less content with what Mr. Phillips calls "antiquated ding-dong methods," the business would not have fallen into disrepute as "uncertain and precarious" in its profits and capital would have been as ready to embark as it is in the United States and Germany. At all events the way out is by modernising the iron and steel making plant; modernising means investment of capital, and we venture to predict that the capital will be forthcoming.

Combined Trolley and Conduit Tramway Systems.

In a very practical paper read before the Institution of Mechanical Engineers, Mr. A. N. Connett gives some of the results of his wide experience in America and Europe in the construction of conduit roads, and speaks particularly of combined trolley and conduit systems.

"In many cities where the overhead trolley is admitted on surface tramways, there often exists a street or a central zone where it is expressly prohibited." Other cities forbid the trolley to enter their boundaries at all, and when suburban trolley lines reach the city limits a change of cars is necessary, or else the cars must be equipped so that they can use another system of traction. There is no one plan which is best under all conditions, but that which is generally adopted is the combined trolley and conduit system.

"The problem of adapting the plough and track mechanism to change from the overhead line to the conduit system, or vice versa, has been satisfactorily and carefully worked out on several different general principles. In America, where the conduit has been generally adopted in the cities of New York and Washington, the problem of a mixed line has received very little consideration, but on the continent of Europe there are a number of systems of this kind, and they are all worthy of attention, the problem having received careful study in each case. This, in the author's opinion, is only one instance in several, where European tramways now offer a much more fruitful field for study than American, especially so to the engineer called upon to install a system in Europe under European conditions and requirements."

In regard to the question whether the conduit shall be of side-slot of centre-slot construction, the author believes that "if the engineer has his choice he will undoubtedly adopt the latter type. But on the Continent there is an objection on the part of the municipal authorities in some of the cities

to the centre-slot. The advantages of the side-slot conduit are that the additional band of iron in the street required by the centre-slot rails is avoided, and that the maintenance of the paving is thereby simplified, every joint of a rail with the paving being a sourse of weakness in the life of the latter.

"The principal trouble with the side-slot conduit is that connected with the switch. In the case of the centre-slot a comparatively light movable tongue can be hung or pivoted to the fixed tongue, its use being simply to guide the plough. With the side-slot the tongue is much stiffer and heavier, because it must also guide the wheels of the car and support them in one position; that is, the entire tongue is movable, and its upper surface from point to heel must be level with the wheel rail. To avoid troubles at the switch the author suggests that before the switches are reached, the side-slots should be deflected to a central position. There are no mechanical or electrical difficulties in this case, as demonstrated by the results of actual operation in Paris.

"The first decision to be made for a line partly conduit and partly overhead is whether the plough shall be carried continually on the car, or removed and replaced at each junction point of the two systems. The latter is the simpler method. A roomy manhole containing a man to do this work is all that is needed; but it requires no argument to prove that this is undesirable and expensive. One is then impelled to a method whereby the plough is always carried on the car and can be raised or lowered at junction points. The most natural and neatest solution of this problem is to raise the plough through the slot with no special arrangement in the latter. This has been successfully done in Berlin and Brussels. In the former city the plough is equipped with a wheel at its lower extremity, which runs up an inclined plane; and the contact-shoes working on horizontal axes pass through the slot by being depressed to a vertical position. The wheel then runs in the groove of the wheel rail, and is raised clear of the track by the turn on a crank given by the motor-man. At the same time, the conductor loosens the bow sliding trolley, and the operation is complete. The entire change can be made without stopping the car. In Brussels the plough is raised by the motor-man, the inclined-plane feature being discarded. A wheel-trolley is used, so that a stop is necessary to catch the trolley-wire.

"In these two cities the ploughs are not mounted on slides permitting a lateral motion across the car, and the two slots of a double-track road being located on the interior rails, it is necessary to carry two ploughs with a raising and lowering mechanism for each. If the requirements of the road demand cross-over switches from one track to another, a third conduit is necessary for a short distance at such points."

But by the use of a system of slides and plough-construction devised by the author, the plough can be shifted from one side of the car to the other and can be lifted out of the slot when necessary. With this construction and with the deviation of the side-slot to the centre before switches, the need of two ploughs and a third conduit is entirely obviated. The best form of contact shoe does not permit the plough to be lifted through the narrow slot, and a movable trap has to be employed at junction points. On some French roads where this system is used, a man opens the trap, raises or lowers the plough and closes the trap while the conductor lowers the trolley from or raises it to the trolley-wire. The whole operation takes on the average ten seconds, and as these junction points generally coincide with stopping places to load or discharge passengers, practically no time is lost.

The author gives some interesting figures concerning the cost of conduit roads, based on actual experience, which cannot be given here for lack of space, and for which the reader is referred to the full text of the original article.

REVIEW OF THE CONTINENTAL PRESS

The Zeppelin Air-Ship.

ALTHOUGH there have been many general accounts of the flights of Count Zeppelin's air-ship over the Lake of Constance last summer, they were nearly all deficient in the details which are of such great importance in forming a correct judgment of the experiments, but in a recent issue of the *Zeitschrift des Oesterreichischen Ingenieur- und Architekten-Vereines,* Captain Hermann Hoernes gives a very complete description of this remarkable balloon and its three trial trips.

As is generally known, this air-ship is in the shape of a long cylinder, with ogival ends. To be more precise, the cross-section of the central body is a polygon of twenty-four sides. The aluminum framework is 128 meters (420 feet) long, 11.3 meters (37 feet) in internal, and 11.66 meters (38.25 feet) in external diameter. The capacity of the balloon is 11,300 cubic meters (400,000 cubic feet) and the total weight about 10,200 kilograms (22,500 pounds). This shows it to be the largest balloon that has ever flown. The framework is built up on sixteen 24-sided rings, formed of lattice-work 18 centimeters deep. These rings are stiffened by tie rods running directly across, and also by spokes fastened tangentially to a one-meter central ring. The longitudinal members which connect the rings are likewise latticed, and are stiffened every 80 centimeters by aluminum straps. Beyond the end rings, the longitudinal members gradually converge to the bow and stern. The aluminum framework is covered, inside and out, by a network of thin ramie cord, with a mesh of 20 to 25 centimeters.

There are seventeen compartments formed by the rings, and in each is an independent balloon, which was filled with hydrogen gas before the trips. The compartments are each 8 meters in length, except those directly above the two cars, which are 4 meters long.

The balloon envelopes are made airtight with a preparation called ballonin, invented by the Finnish æronaut Lievendahl. Each balloon has an automatic safety-valve, and five of them are provided with manœuvering valves, which are operated from the cars. The outer covering of the framework is not airtight. It serves merely to give the ship a smooth surface, offering little resistance to the air, and to protect the inner balloons from atmospheric influences. The under side of this covering is therefore of very light silk, while the upper side is of waterproof material.

The two pontoon-shaped aluminum cars are 6 to 7 meters long, 1.8 meters wide and 1 meter deep, and, when empty, weigh 220 kilograms. They have double bottoms, holding water ballast. They are fastened 2 to 3 meters underneath the body of the ship by aluminum tubes, at a distance of 34 meters from the bow and stern respectively, and between them stretches a latticed stiffening girder 60 meters long and 1 meter deep.

In each car is a Daimler benzine motor, with electric ignition, which develops 16 horse power at 700 revolutions per minute. The weight of this motor, with flywheel and cooling-water pipes, is 450 kilograms, or about 28 kilograms (62 pounds) per horse power. The consumption of benzine is about 0.375 kilograms (0.83 pounds) per horse-power hour, and as the capacity of the tanks is 60 kilograms, enough fuel is carried for a flight of ten hours. These motors were built more than two years ago, and although they are light compared with those used on former air-ships, their makers have since attained much better results.

Each motor, through gearing and rods with universal joints, drives two aluminum screw propellers, placed high up on the balloon's side, with their centers about 1.5 meters therefrom.

The propellers are comparatively very small, only 1.15 and 1.25 meters in diameter: they weigh 15 kilograms apiece, are four-bladed and make 1,100 revolutions per min-

ute. Water ballast is carried in two bags, holding 200 kilograms apiece, placed inside the framework, and arranged so that 20 kilograms can be emptied at a time. These bags are situated near the bow and stern respectively, and there are twelve more, holding 50 kilograms apiece, placed near the middle of the ship. Furthermore, there are four bags, each holding 40 kilograms of wet sand, fastened to the stiffening truss.

But the air-ship can be raised or lowered otherwise than by dropping ballast or letting out gas. When the balloon's axis is inclined to the vertical, and the propellers are set in motion, the ship is driven to a greater or lesser elevation, depending upon the direction of the axis. In order to give the balloon this inclination, there is a cigar-shaped block of lead, weighing 150 kilograms, attached to a small carrier running on the stiffening girder. This carrier is moved back and forth by thin wire ropes leading to the cars.

The steering apparatus underwent many transformations in the course of the experiments, but at the time of the last ascension there were three rudders, a horizontal one forward, to direct the ship up- or downward, a small vertical one forward and a large vertical one aft, all underneath the body of the balloon.

The air-ship was built in a floating boat house, so that it could be launched in the direction of the wind. It rested on a float, which was drawn out of the boat house whenever a trip was undertaken.

The first ascension was made on July 2, in the early evening. Count Zeppelin and two assistants were in the forward car, while the after car carried two men. As the air-ship began to rise, some of the after lines were held too long, in consequence of which the ship, instead of ascending in a horizontal position, had its bow pointed upwards. The movable weight was therefore hastily pulled forward, which made the bow sink too low, and when Count Zeppelin tried to bring the weight back to its central position, some of the apparatus broke and the weight would not move. In the meantime, the ship had ascended to a height of 300 meters above the lake, and after making some distance against a very light breeze, the steering lines became jammed, and the ship was henceforth compelled to run before the wind. On this first trip there was no stiffening truss, and the framework of the balloon showed signs of bending.

So after a flight of about seventeen minutes' duration, the ship descended, but in settling down upon the water, it ran into a stake used to mark the channel, which had been observed in the twilight, and sustained some damage.

This first trip showed that various changes were necessary, and in carrying out these alterations and in making repairs, over three months were consumed.

The second ascent was made on October 17, in the late afternoon, and a successful flight of about an hour was brought to a close by the escape of the gas in the third balloon, which caused the forward end to sink more than could be counterbalanced by the movable weight. The ship, therefore, drove rather rapidly downward to the water, but was not seriously hurt by the shock.

There were some slight damages, which it took a few days to repair, and the third—and, so far, the last—flight was made on October 21, during a dead calm. This trip, although it lasted but twenty-three minutes, was of particular interest, because the ship described a figure-of-eight course and descended very near the starting point. Although it settled down on the water gently, it sustained, as usual, some strains and slight damages, and as the autumn was so far advanced, no more trips were undertaken that season.

Captain Hoernes criticises several features of the Zeppelin air-ship, among which may be mentioned the low power, only 32 horse power, for such a large vessel. Even this power does not appear to be used to the best advantage, on account of the small diameter of the propellers and their large number of blades. The ship with its present power would be unable to make any headway against even moderate winds, which, of course, limits its practical use.

The rigid frame, with its outer covering of silk and waterproof stuff, makes it very hard to land without sustaining some damage, and in a high wind the balloon would surely be injured.

The rapid ascent and descent of the ship can be accomplished only by dropping ballast or by letting gas escape, and for a flight

of long duration, this would hardly be practicable.

Another objection to the Zeppelin ship is its lack of stability, owing to the height of its center of gravity.

In spite, however, of all these difficulties in the way of the extended use of this airship, the experiments made have been very instructive and of real service to the science of aeronautics, and they may help to point the way to a successful solution of the problem of aerial navigation.

The Economy of Electric Traction in France.

WHILE the displacement of animal traction by electric on street railways is generally an unmixed benefit to the public at large, there may sometimes be a question whether, all things considered, the owners of the road derive a net profit from the change. This question is discussed in a recent issue of *Le Génie Civil*, where the problem is stated in the following way:

Having given a tramway system with animal traction:

1. What will be the cost of electrical equipment?

2. Will the increase in net receipts resulting from the change be sufficient to augment the rate of interest on the total capital invested?

By "total capital" is meant both the original capital invested in the horse railway and the cost of the electrical equipment.

In considering this question of new equipment, we may assume that the tramway systems have no competitors within their respective districts and are therefore not obliged to improve their operating methods in order to hold their old traffic. In this respect they differ from a factory or machine works, which is compelled to better its equipment and modernize its methods, or else be forced to the wall by wide-awake rivals. With the tramways we are discussing, the improvement was not a matter of life and death, but could be considered simply with reference to its effect upon operating expenses and receipts.

The data for the discussion are taken from the experiences of six French tramway systems in the cities of Rouen, Le Havre, Versailles, Nancy, Amiens and Roubaix-Tourcoing, which have recently changed over from animal to electric traction. The results are analyzed in a number of tables, which show very clearly the effects of the change.

The most characteristic feature of the substitution of electric traction for animal is the increase in the number of passengers carried, which shows very clearly that the new system enjoys the favor of the travelling public. This increase varied from 209 per cent. in Rouen to 37 per cent. at Roubaix-Tourcoing.

When the change was made, the accompanying increase in length of track varied from 91 per cent. at Havre, to 7 per cent. at Roubaix-Tourcoing, so that the number of passengers carried per kilometer of track increased from 143 per cent. in Rouen to 21 per cent. at Versailles. This increase per kilometer is generally considerably less than the total increase, which is accounted for by the fact that the new portions of the roads are in outlying districts where the traffic is naturally not so heavy. So in order to get an idea of the increase in traffic on the old portions of the roads, we may take a mean between the last two sets of figures. The increase in the number of trips per inhabitant varied from 197 per cent. at Rouen to 28 per cent. at Roubaix-Tourcoing.

In order to provide for the increased traffic, and also to incite it, cars are run much oftener. This frequency of traffic is one of the most telling causes for the popularity of the electric roads, but it cannot be increased indefinitely without lowering the net profits. To find the most profitable frequency is a complicated problem, whose solution varies from case to case and depends entirely upon experience. The opinion of M. de Marchena on this subject may be quoted: When a line is overloaded with passengers, the receipts increase in proportion to the number of cars in service, but after reaching a certain point, which might be called the "saturation point," the increase in receipts grows less than the increased frequency of service. Nevertheless, when the operating expenses are small, it is profitable for the road to pass this point and increase the service as long as the extra receipts exceed the extra expenses. The more economical in operation a system is, the farther is it possible to go in this direction. With

electric traction in particular, a railway is not being worked to the best advantage until the activity of circulation is such that each car carries only a few passengers. This may appear paradoxical at the first glance, but it is nevertheless a fact. In this way, the interests of the public and of the railway company are intimately connected, and the latter seeks to realize the maximum profit by lowering the fares and increasing the service as far as the resulting increase in traffic will warrant the greater expense.

The increase in the number of car-kilometers varied from 208 per cent. at Versailles to 57 per cent. at Nancy.

The increase in gross receipts varied from 158 per cent. at Versailles to 49 per cent. at Nancy. These figures, owing to the lower fares, are not the same as those for the increase in number of passengers. The receipts per car-kilometer show a *decrease*, varying from 24 per cent. at Rouen to nothing at Amiens. This decrease may be due to either of two causes: the smaller number of passengers per car-kilometer, or the lower average fare. These two causes tend to counterbalance each other, and the rates are so adjusted that the resultant effect is kept as constant as possible.

It is found, on the whole, that there is a notable increase in the gross receipts, owing chiefly to the increase in frequency of service, in speed and in comfort.

Turning now to the other side of the account, we find that the decrease in operating expense per car-kilometer varied from 53 per cent. at Rouen to 15 per cent. at Havre. But owing to the much greater number of car-kilometers with electric traction, the total operating expenses increased. This increase varied from 90 per cent. at Versailles to 36 per cent. at Rouen, but in every case it was less than the increase in gross receipts, so that there was a gain in the net receipts, which varied from 1035 per cent. at Rouen to 136 per cent. at Nancy. At Versailles the result was even more remarkable, for, whereas formerly there was an annual deficit of 13,000 francs, the net receipts are now 76,000 francs.

On comparing the net receipts with the capital investment, it is found that under the old system of animal traction the ratio varied from 9.77 per cent. at Havre to —0.68 per cent. at Versailles, a deficit occurring at the latter place, as already mentioned. When the *gain* in net receipts under electric traction is compared with the cost of the *new* equipment, the ratios vary from 9.71 per cent. at Havre to 4.16 per cent. at Amiens. The final table shows the ratios of the total net receipts under the new order to the total capital investment (including the original investment in the horse railway and the cost of the electrical equipment), and the figures run from 9.47 per cent at Havre to 2.11 per cent. at Versailles.

Notwithstanding the much larger investments, there is here shown an increase in the rate of dividends in every case except at Havre and at Amiens. At Havre, which shows the greatest profits under both systems, the difference is but small, and at Amiens the figures for the horse railway were taken in an exceptionally favorable year, while those for electric traction were taken in the first year of operation, before the system had a firm footing, so that here the true showing would be more favorable to electric traction than is indicated in the table.

The final *increase* in the rate of profits is 0.52 per cent. at Nancy and Roubaix-Tourcoing, 2.79 per cent. at Versailles, and 4.74 per cent. at Rouen. Except at Rouen, where the profits increased from 1.61 per cent. to 6.35 per cent. and at Versailles, where a deficit of 0.68 per cent. was converted into a profit of 2.11 per cent., these results are not startling, and show that in France, at least, electric tramways do not offer very extraordinary inducements to investors of capital, however much they may benefit the public.

Fly Wheels for Internal-Combustion Motors.

One of the portions of engine design which has received much attention from writers of high authority is that which relates to the design and proportion of fly-wheels, and from the older method of rule of thumb there has grown a number of empirical rules. All these, however, relate to the double-acting steam engine, in which there is an impulse of greater or less duration and magnitude in every stroke. In the case of gas engines and other motors, operating on the Beau de Rochas cycle,

however, there is but one power impulse in every four strokes, in addition to which there is a compression stroke in every four which must be effected by the energy stored in the fly wheel. For these reasons the conditions affecting the weight of the wheel for a required steadiness of revolution are altogether different from those which obtain in the steam engine.

This whole subject of the proportions of fly wheels for internal combustion motors is discussed in a paper by Herr Hugo Güldner, in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure* in an exhaustive manner, and while a full examination of his treatment can only be made by reference to the original papers, the method and some of the results may be briefly noted.

The very variable character of the quantities involved render it almost impossible to apply any analytical treatment, and the same reasons make the graphical examination particularly applicable, especially as indicator diagrams supply the data for nearly every type of engine which may come under examination. By taking the pressures at every point of the stroke for one or more complete cycles, and converting them into the equivalent tangential impulses and retardations the irregularities to be equalized by the fly wheel are not only made visible but also rendered suitable for measurement and computation.

Herr Güldner has worked out such tangential diagrams for a number of internal combustion motors, including the Hornsby-Akroyd, Hille, Körtung, Westinghouse, Bànki and Diesel; the latter including diagrams from the air compression pump which forms an essential part of the machine and is driven by it. These diagrams are then made the subject of computations, the areas being measured by the planimeter, and the relation between the impulses and the resistance expressed by equations for practical use in computations.

For the usual four-cycle motors Herr Güldner gives the following formula, which he states gives results within 2 per cent. of those made by plotting the actual diagrams and measuring the quantities.

$$G = \frac{(0.75 + r)\ 8200\ N}{d\ R^2\ n^3}$$

In this formula G is the weight of the rim in metric tons of 1,000 kilogrammes (2,208 pounds), r is the value of the mean compression pressure divided by the mean impelling pressure, d is the percentage of variation of speed, that is, the difference between the maximum speed and the minimum speed, divided by the normal speed, N the indicated horse power of the motor, R the radius of the fly wheel, and n the number of revolutions.

The following values of r are given as corresponding to good practice for the various classes of motors:

Gas engines with illuminating gas ..... r 0.25 to 0.35
Gas engines with producer gas ..... r 0.40 to 0.50
Petroleum engines..... r 0.30 to 0.40
Benzine motors..... r 0.10 to 0.20
Diesel petroleum motor..... r 0.48 to 0.52

Herr Güldner gives numerous tangential diagrams for motors with more than one cylinder and for various successions of power strokes, and for such it is best to construct to corresponding diagrams in each case and deduce the proper weight of fly wheel accordingly. This method is really to be preferred in any case, as it enables the conditions to be seen at a glance. For new engines of which indicator diagrams have not been taken, the theoretical diagrams may be constructed, or actual diagrams taken from existing engines of similar type may be used.

The paper contains much valuable information concerning the equalisation of irregular impulses by means of rotating masses, and similar methods are applicable to other than internal-combustion motors.

The Rasch Arc Lamp.

COMMENT was made in these columns last month upon the form of arc lamp devised by Herr Ewald Rasch, in which the arc is established between terminals of refractory materials which have been rendered conductors by preliminary heating. As might have been expected, this is followed by a communication from Dr. Nernst in the Elektrotechnische Zeitschrift, criticising the estimates of illuminating efficiency made by Rasch, and also showing that the new light was partly at least anticipated by himself.

Dr. Nernst very properly remarks that

comparisons can be made only upon the spherical candle-power, and when the figures for the continuous current and alternating current arc lamps, as well as the Nernst incandescent lamp are reduced to spherical candle-power the showing is much better for them. Taking some tests by Wedding. it appears that for a 9-ampere arc lamp the mean effect was 1.38 watts per candle for the space below the horizontal. This was for the alternating current, and as the distribution of light in that case is the same above and below the horizontal, this may be taken as the spherical candle power. Taking a continuous-current arc lamp, the energy required was about 0.5 watts per candle below the horizontal, and neglecting the space above the horizontal, this should be doubled to give the spherical candle-power. In actual practice, taking into account the necessary resistances, Wedding considers that average values are 1.9 watts per candle for alternating lamps, and 1.37 watts for continuous-current lamps.

Taking the electrolytic incandescent lamp bearing his own name Dr. Nernst shows that the mean spherical illumination is produced by an expenditure of 1.73 watts per candle, or allowing for the necessary resistance, it may be placed at 1.9 watts, or about the same as that of the alternating-current arc lamp.

In the course of his experiments upon his incandescent lamp Dr. Nernst also examined the action of arcs between electrolytic terminals, such arcs being naturally formed when at any time the filament of his incandescent lamp parted. According to his observations of such arcs, the very high temperatures produced a material vaporisation of the electrodes, and these latter were far from being permanent. It is interesting to learn that the consumption of the terminals was in the opposite direction to that of the carbon arc lamp, the negative pole being wasted away more rapidly than the positive, a circumstance which may throw light upon the theory of the arc.

For the same materials used in the Nernst incandescent lamp it appears that the life of the electrodes would be very short, but as the exact composition of the electrodes used by Herr Rasch has not yet been made public, it is too soon to form positive conclusion as to this important point.

There is no doubt that the points raised by Dr. Nernst are of much weight, based as they are upon his own experience in similar lines of reseach. At the same time the new light apears to be of so much promise that it is to be hoped that his objections are largely due to insufficient information. At the same time his caution as to the necessity of using the same standard of illumination when comparing different lamps is very well taken, and before any opinion can be formed as to the real illuminating value of the various kinds of arcs, it must be made sure that the data have all been reduced to the same standard.

It seems as if the electric lamp, so long stationary, has again become an object of attention on the part of investigators and inventors, and with the attention now being given to both arc and incandescent lamps, there is every probability that marked practical improvements will result.

State Railways in Prussia.

In the course of a recent debate in the Prussian House of Deputies over a railway accident at Offenbach, there were brought out many facts concerning the state railway system of Prussia, which were of so much technical and economic interest that the *Zeitschrift des Vereines deutscher Ingenieure* gives a very full report of the discussion, and adds thereto the opinions of four outside professional railroad men of great ability and experience who speak without any official bias.

One of the deputies, Herr Macco, emphasised the tremendous influence on the public welfare which is exercised by the state railways, and said, very properly, that they should take the lead in progress and in the introduction of modern improvements. He declared that the members of the technical staff were fully competent to carry out reforms, but that they were bound and fettered by a rigid system, and he went on to instance some of the particulars in which the Prussian state railways are behindhand.

This railway system is only now proceeding to substitute rails weighing 42 kilograms per meter (84 pounds per yard) for those of 32 kilograms (64 pounds), whereas in other countries the best railway practice employs 100-pound rails.

The road bed is good when new, but there are not large enough appropriations for proper maintenance of the permanent way, which in consequence inevitably soon falls out of repair.

Some improvements in passenger cars have recently been made, but they were not due to the initiative of the Prussian officials, being largely copied from American practice, and were generally carried out only after continued agitation of the subject by private persons.

It appeared further, from the remarks of Herr Macco and the subsequent reply of the Minister of Public Works, Herr von Thielen, that while the freight car system is a very uniform one, it is lacking in many particulars. The cars are of comparatively small size, even the latest ones having a capacity of only 15 tons. The dead weight of the car is 50 to 60 per cent. of the total weight, as against 25 per cent. in some other countries. While it is admitted that the shippers themselves may not be quite ready for radical changes, it is claimed that the railway authorities should look a little ahead and prepare the way. The facilities for rapid unloading are poor, and the freight cars have neither air-brakes nor automatic couplers.

It is generally agreed that the locomotives are very efficient, from a thermodynamic standpoint, and that for ordinary traffic and small trains they are satisfactory.

But while the efficiency of the locomotives is good, and their construction strong and durable, they are lacking in capacity. They are not powerful enough to haul heavy trains at high speed, and it frequently happens that express trains have to be supplied with two engines. One reason for the comparative lightness of the Prussian locomotives is the state of the permanent way, which limits the allowable weight per axle to 16 tons, whereas in America the axle loads go as high as 21 or 22 tons.

This lack of power in locomotives limits the economy of transportation, and in spite of the great cost which must be incurred in strengthening the permanent way, it is felt that the Prussian railway authorities will be compelled to follow the example set in other countries and make the improvements.

One critic alleges that the Prussian locomotives are built too well, so that they become antiquated before they wear out, and are retained in service longer than good practice warrants. This inherent inertia is one of the weakest points of a system of state ownership of public utilities, and the general arguments against such a system are well put by one of the technical men who was interviewed:

For every important problem which demands solution, it is not possible under a system of government ownership, as it would be in a private enterprise, to pick out a specially able technical man and give him the necessary far-reaching authority to settle the difficulty. The organisation does not permit the individual even to make proper use of his abilities. Not one head and one will governs, as must be the case when important problems are to be solved satisfactorily, but many. On account of his many routine duties of management, and the frequent shifting from place to place, the engineer has neither time nor opportunity for technical work. The authority of the higher officials over their subordinates is not great enough to force the introduction of useful and practicable innovations against the opposition of the latter.

Under the present Prussian system, the technical men, particularly the mechanical engineers, occupy an insignificant position, so that technical improvements which necessitate preliminary studies, costing money, and a certain freedom of action, are made practically impossible.

Any government railway system under such conditions will be obliged to imitate more or less slowly the improvements introduced on private lines in other countries, and cannot hope to take the initiative itself until it provides for an efficient technical staff entirely free from the hampering bonds of a bureaucratic administration.

Accumulator Cars on Standard Railways.

A BRIEF reference has already been made in these columns to some experiments with accumulator cars on sections of the Bavarian Palatinate railway system, but since then Herr Gayer, under whose direction the operations were conducted, has delivered an address before the "Verein für Eisenbahnkunde," which has been published in *Glasers*

Annalen, and from which some of the details are abstracted.

These cars are run on sections where there is not enough local traffic to justify the operation of many way trains with steam locomotives, and yet where a frequent service is very desirable. They also act as feeders for through express trains by picking up passengers at way stations and carrying them to the express stopping places.

That the accumulator cars have found favour with the public is shown by the fact that in 1900 the few that were then in operation covered 96,912 kilometers on main lines and carried 303,222 passengers.

The experiments on the main line were begun in 1896, and the only serious difficulties met with were in the accumulator plates, which was not to be wondered at, as there had previously been no practical experience with accumulator traction on such a heavy scale. These difficulties were successfully overcome, and the accumulator company was finally able to furnish batteries which worked satisfactorily in every respect. When this stage was reached, new cars were provided and were put in operation early in 1900. Two of these are four-axle cars, with a seating capacity of 112, and two are three-axle, carrying 68 passengers. The four-axle cars have a center aisle and are 17.86 meters long and 3 meters wide. These cars have three compartments, the middle one being third-class, while the end ones can be used as second- or third-class, as desired. On some of the trips an ordinary third-class trailer is carried, which adds fifty to the seating capacity. The seats are placed across the car, back to back, and in order to provide for rapid emptying of the car, there are six doors on either side of the long central compartment, besides the doors for the end compartments. At the extreme ends of the car are the compartments for the motorman, which are provided with speed indicators, besides the usual controllers, meters and brakes. The cars are heated and lighted with current from the accumulator cells, which are placed in wooden boxes under about two-thirds of the seats. These boxes are carefully lined with isolacite and linoleum, have an outlet at the bottom for any acid which may slop over, and are ventilated to allow the escape of fumes. There are six cells in each box, each cell containing seven positive and eight negative plates, 30 centimeters square. The connections are not soldered, but screwed, so that the individual cell can be easily removed, and as the seats forming the tops of the boxes turn back, all parts of the battery are easily accessible at all times for inspection and repair.

Each car carries 156 cells, with a guaranteed capacity of 225 ampere-hours, and as only about 120 ampere-hours, on the average, are consumed on the longest run, there is a reserve of about 90 per cent. This large reserve was provided in order to avoid discharging the batteries too far and also to allow for any depreciation.

The batteries are charged at the end of every trip for a time varying from 30 to 75 minutes, with a current of 150 to 200 amperes. For each car there are two four-pole motors, which drive both axles of the truck through gearing with a ratio of 1 to 3. The cars run at an average speed of about 40 kilometers per hour, and cover about 150 kilometers a day.

The empty cars weigh about 26,000 kilograms, the batteries about 15,000 kilograms and the motors 4,000 kilograms, a total of about 45,000 kilograms, or nearly 45 long tons. When carrying 106 passengers, a motorman and a conductor, the total weight is about 53,000 kilograms, or about 6,600 kilograms load per wheel. Even allowing for the large number of passengers carried, the dead weights of these cars compare very favourably with those of ordinary trains.

The cost of a car such as has been described, with its electrical equipment, is given at about 55,000 marks. Allowing for depreciation of the battery and assuming its electrical efficiency to be 65 per cent., and also assuming that current costs 10 pfennigs (2.4 cents) per kilowatt-hour, it is found that the total operating expense, taking interest, depreciation and everything else into consideration, is 27.52 pfennigs per car-kilometer (10.5 cents per car-mile), or 0.26 pfennigs per seat-kilometer (0.1 cent per seat-mile. These figures are lower than those for steam traction under similar conditions, and there are so many other advantages connected with accumulator traction on the lines about Ludwigshafen and its neighbouring cities, that it has gained a permanent position.

REVIEW OF THE AMERICAN PRESS

Volcanic Disturbances in Nicaragua.

WITH the closing of the Fifty-sixth Congress, the Isthmian Canal has temporarily passed into a less prominent place in the public view. It is possible, and very much to be hoped, that these comparative lulls in violent partisan advocacy of a particular route will tend to advance general education in the real merits of the question, and so aid in permitting a final solution based on sound engineering and commercial principles.

The *Railroad Gazette,* which has always ably championed the cause of full enlightenment before action, publishes some very striking excerpts from a series of lectures by M. Bunau-Varilla, a distinguished French engineer who has recently travelled in America and lectured on the Isthmian Canal projects before engineering and commercial bodies. The lectures have been published independently in pamphlet form, and with their graphic charts afford the most striking demonstration of comparative length, curvature, magnitude, cost, and conditions affecting stabilty that we have yet seen. The extracts in the *Gazette* relate to the probability of volcanic disturbances along the two routes. M. Bunau-Varilla was formerly engineer-in-chief of the Panama Canal, is a director of the Congo Railroad, and president of Spanish coal and rail enterprises. He is therefore fitted, as the *Gazette* points out, to speak with special knowledge and with the responsibilty of one accustomed to great enterprises.

The danger from seismic disturbances during and after construction, he points out, was not discussed by the United States Isthmian Canal Commision in the preliminary report, and yet it is one of the most serious considerations in the problem.

"It is entirely false to compare the equilibrium of dams and locks with that of a high tower of a church. A wall or tower, even fissured, can stand after an earthquake. A longitudinal fissure in a dam, which will not alter its equilibrium as a wall without pressure of water, would mean its immediate overthrow when the water pressure is exerting its force upon the surface of the inside fissure.

"Outside of the danger of seeing ruined the dam or the locks by a great seismic commotion, one must not forget that there is great probability of seeing formed in the sea of Nicaragua, which is 100 miles long and 45 miles wide, one of those terrible tidal waves which were so destructive in Lisbon (earthquake of 1752), and Krakatoa, 1883, the latter being 100 ft. high and the former 40, causing unlimited disaster.

"It must be borne in mind that these menaces would mean, if realized, not only the destruction of that costly canal, but the ruin of the interests of both sides of America, which will have been developed by the great waterway."

The comparative exposure to risk from volcanic or earthquake disaster should therefore be examined most carefully in making a decision between the Panama and Nicaragua routes. "In Panama, there is within a distance of 180 miles from the canal no volcano, even extinct." The isthmus there has not been modified since the quaternary period. Nicaragua, on the contrary, has always been the site of seismic convulsions. The lake was formerly a gulf in the Pacific; the name is "associated with the most terrible volcanic explosion ever recorded in history before the Krakatoa explosion in Sound's Islands."

"The explosion of the volcano Coseguina in 1835 lasted 44 hours, the noise was heard at a distance of 1,000 miles, the ashes were brought 1,400 sea miles by the winds; * * * during these 44 hours the volcano ejected every six minutes a volume of stone and ashes equal to the total volume of the prism of the Nicaragua Canal, as it was calculated by the Nicaragua Canal Commision, and which will necessitate eight years of excavation.

"In the very center of Lake Nicaragua is a volcano in constant activity, the Omotepe, whose last great eruption occurred in 1883.

"Between the two above named volcanoes we find a series of volcanoes in recent or continuous activity, the Hell of Masaya, on the shore of Lake Nicaragua, the celebrated Momotombo, on the shore of Lake Managua, the volcano of the Pilas, which was born in 1850, the Santa Clara, the Zelica, the Nindiri, being the best known of them."

According to the appendix to the Nicaragua Canal Commision's report: "In the northwestern part of Nicaragua, slight earthquakes are frequent. Scarcely a month passes without one or more being noticed. The center of these disturbances is always near the line of the Nicaragua volcanoes; the line of volcanoes begins with Madeira (near the Omotepe), at the southern end, in Lake Nicaragua, and terminates at Coseguina, at the northern end, near the gulf of Fonseca."

M. Bunau-Varilla enforces his observations by citing "two most important facts * * * recently established by M. Bertrand, geologist and member of the Institute of France:

"1. The Lake Nicaragua is one of the three lines of least resistance in Central America, which are a site of election for great seismic disturbances. It is the line of depression between the Costa Rican volcanoes and the Nicaraguan, and plays the same part as the other two; the bay of Fonseca, which is a volcanic lake characterizing the depression between the Nicaraguan and Salvadorian volcanoes, and the Lake Pacayan, characterizing the depression between the Salvadorian and Guatemalan volcanoes. These two last lines of least resistance have been the site of the most terrible convulsions owed to the Coseguina for the former and to the Fuego (Fire) for the latter.

"2. The underground fire is going south, and increasing in Nicaragua. From the figures given by M. Bertrand I calculated that before the nineteenth century, out of all the great explosions or earthquakes recorded. 45 per cent. belonged to Guatemala, 35 per cent. to Salvador, and 20 per cent. to Nicaragua, whereas in the nineteenth century only 30 per cent. belonged to Guatemala, 45 per cent. to Salvador, and 25 per cent. to Nicaragua, showing an evident tendency to a displacement of the activity southward and an increase in Nicaragua.

"To justify these figures one can say that several volcanoes became extinct in Guatemala, and that none was extinct in Salvador or in Nicaragua, but, on the contrary, that two were born in Salvador, Izalco, in 1770, and Ilopango, in 1880, and one was born in Nicaragua, that of Las Pilas, in 1850.

"Nothing similar can be feared in Panama, as no trace of any local volcanic activity may be found on that Isthmus, whose rare and small seismic vibrations come from distant centers."

Train Lighting by Electricity.

IN a recent paper before the St. Louis Railway Club, Prof. Geo. D. Richardson sketches the history of car lighting in general and gives a very interesting account of the present state of train lighting by electricity in particular.

After tracing the development of train lighting from penny candles to Pintsch gas, the author dwells on the great advantage of the electrical incandescent lamp, and then proceeds to consider the various methods which have been used for lighting trains by electricity, and which may be grouped under three general heads, according to the source of current supply—the storage battery alone, the dynamo alone, or the dynamo and the storage battery combined.

"The use of storage batteries on trains dates from October, 1881, when a Pullman car running between London and Brighton, England, was equipped with storage batteries which were charged at London during the night by a special engine and dynamo. In April, 1885, the Pennsylvania road equipped eight parlor cars with storage batteries." .Other roads built took up this system, but the accumulators of that day were far from perfect, and in several cases battery lighting was abandoned. "The early practice was to run the cars to the charging station, where the exhausted cells were removed and replaced by others freshly charged. This required much hand labor and the handling was found to be very hard on the cells. The later practice is to charge the batteries while the car is lying in the yard for cleaning, or to charge them while the train is running. One of the best illus-

trations of the simple battery system is that used on the Burlington Limited, running between Chicago and Minneapolis. Each car carries forty-eight accumulator cells, weighing fifty-six pounds each. These are carried in trays holding six cells apiece, four trays being carried in a box, one on each side of the car. The battery equipment is less than two per cent. of the average weight of the cars in these trains. Each train leaves one terminal in the evening and arrives at its destination the next morning. While the yard men are cleaning the train, the batteries are charged without being removed.

"On account of the deficiencies of the early storage batteries, various attempts have been made to operate electric lamps without batteries. The simplest way would be to drive the dynamo directly from the car axle, but some source of power must then be supplied to operate the lamps when the train is at a standstill. Other sources of power were therefore sought. In 1884, Preece tried an engine operated by compressed air pumped into a reservoir by a pump attached to the car axles. Similar schemes were patented in this country by Moskowitz. In a few cases an oil engine has been tried, and it has even been proposed to use the compressed gas now used for lighting to drive a gas engine and a dynamo. Another plan was to place a steam boiler with engine and dynamo in the baggage car, or in a special car for furnishing light and steam heat. This was tried on an English road, and also was used for about two years (1890-1892) on the Chicago, Milwaukee & St. Paul road. The more common and successful plan is to place the engine and dynamo in the baggage car and obtain steam from the locomotive boiler." Such a dynamo is generally used in connection with a storage battery, which takes care of any fluctuations of loads and provides a source of current when for any reason the dynamo stops running.

"From the beginning, engineers have looked upon the car axle as the most economical source of power for the electric lights. The locomotive develops power much more economically than a small high-speed engine; it causes no vibration when the train is standing; if made to regulate automatically, the cost of attendance is reduced to a minimum, the amount of power required is so small as not to tax the locomotive boiler or engines, and practically all the cost of power is that of the extra coal burned at the locomotive. With the power derived from the axle, each car may be separate, or may be connected with others, as desired; may be placed on a run of any length; has no vibration to disturb the wakeful sleeper; contains no elements of danger; is always ready in the evening or morning, or when going through tunnels; requires little care. The car axle as a source of power has, therefore, proved very attractive to engineers, and also proved to be beset with many difficulties. The three greatest difficulties are that the speed of the train varies so as to tax to the utmost whatever regulating apparatus may be devised; the apparatus is almost necessarily under the car and exposed to the weather; the universal use of bogie, or swivel trucks on American cars complicates the problem of maintaining proper mechanical connection between the axle and the dynamo when rounding curves and crossing frogs and switches. In Europe it is usual to mount the dynamo on the car body, for the car axle is always practically at right angles to it." The power is generally transmitted by means of flat belts of link or solid leather, or of camel's hair, but in some systems a friction drive is used, a flat-faced pulley on the armature shaft being pressed against a larger flat-faced pulley on the car axle. Gearing is also employed by some inventors.

One method of keeping the voltage at the lamps constant while the speed of the train varies, is to secure a variable ratio of reduction between the car axle and dynamo. Below a certain limit of speed of train it is impossible with any system to maintain proper operation of the dynamo, and some automatic device must be provided to cut the dynamo from the battery and lamp circuit below the critical speed. Above this speed, the dynamo may be kept at constant speed by means of friction cone pulleys, as was done by Barrett and by Moskowitz. The plan of Stone, in England, and of Gould, in America, is to maintain the speed constant by allowing the belt to slip.

A more common way of securing constant output from the dynamo is to let its speed vary with that of the car axle, and to change

the strength of the magnetic field to compensate any changes in speed.

"The method adopted by the Consolidated Railway Electric Lighting and Equipment Company is to have a small motor connected with the adjustable arm of the resistance box and governed by a magnet in the main circuit; this motor automatically adjusts the resistance in series with the shunt field coil, so as to strengthen or weaken the magnetic field to compensate for any changes in speed above the critical speed of about 15 miles per hour. Personal observation of the working of this device on the Santa Fe road last December showed that, after the dynamo was connected with the lights, a sensitive Weston volt-meter indicated no perceptible variation of voltage between fifteen miles and the highest speed attained, probably forty miles per hour. In a few cars there was a slight but gradual change at the critical speed when the lights were shifted from the dynamo to the battery or vice versa. In no case was the fluctuation objectionable, and it was probably not noticed by the passengers. In the Dick system the resistance is regulated by an electromagnet. Another method of regulation is that formerly used by Moskowitz and now used by Vicarino in Europe, namely a differential winding on the dynamo field magnets.

All the axle-lighting systems employ a storage battery as an equalizer and an auxiliary. Sometimes one battery is used and sometimes two. "Generally speaking, the systems which use two batteries charge one while the train is running in one direction and the other when the direction of the car is reversed, the lamps being supplied principally from the battery which is not being charged at that time. Some of the manufacturers prefer to supply the whole train from one outfit in the baggage car, others prefer to have each car equipped with its own device in order that each car may be a unit in itself and perfectly independent."

The author quotes many figures from published accounts of the cost of electric train lighting, and concludes that for equally good illumination it can compete with oil or gas in point of economy, while its general advantages place it far in the lead.

The Sanitary Cleaning of Galveston.

THE principles of the sanitary regulation of cities are fairly well established, and in civilized communities generally are reduced to a simple and unobtrusive routine, being for the most part of a preventive rather than an aggressive character. But the Anglo-Saxon world-police, reducing to order the uncivilized and unruly tribes of the earth, often find it necessary to make sanitation a very active matter indeed, making up by short, sharp methods for long arrears of native neglect. England has cleansed Augean stables all over the world; the United States are taking their turn at the same sort of labor in Cuba, Porto Rico, and the Philippines.

It is rare, however, that the sanitary engineer has so suddenly imposed and trying a problem as Galveston presented after the great storm of Sept. 8, 1900, and the adaptation of methods to the dislocated state of the city affords an interesting study. *Engineering News*, in an extended extract, presents the substance of Mr. George A. Soper's report, to the Chamber of Commerce of the State of New York, of his work in charge of the sanitary restoration of Galveston after its wreck. At the beginning he sets out the conditions which were to be met—the usual outlets for waste destroyed or temporarily useless, drains and gutters choked, outhouses demolished, the contents of vaults and cesspools swept through the city; an army of rescuers, curiosity-seekers, and adventurers added to the surviving population and seeking shelter in the insufficiently cleaned ruins; fouled upholstery, waste of all kinds, and garbage, thrown out without thought of final disposal, decomposing in the yards, streets, and alleys; a "pest of flies," an epidemic of diarrhœa, and the certainty that any acutely infectious disease, once introduced, would spread with great rapidity, and, under "shotgun quarantine," would prove "a greater blow to the city than the storm."

The general plan of immediate procedure adopted was to open a line of easy outlet for the filth by means of an efficient system of street cleaning, and to bring all available pressure to bear on householders to compel observance of sanitary ordinances. Insistence on the deposition of all garbage and refuse outside in proper receptacles, and

provison for prompt removal, effected a rapid disposition of all wastes. Next, a sanitary department was organized:

"(1) The city was divided into five sanitary districts. The area of each district was inversely proportional to the density of the population and to the quantities of refuse which required removal. The force was disposed of in the districts in such a way that the garbage, papers and the like, which accumulated with tolerable regularity, could be removed by carts. The carts followed routes which were covered daily in the thickly populated sections, and three times a week in the rest of the city.

"(2) The number of garbage carts belonging to the health department was greatly increased, and a competent foreman was put in charge of the corps. The garbage was hauled to the east end of the city, and dumped where it might be burned by the aid of house wreckage.

"(3) Dead animals were removed at the owner's expense, and referred to the foreman of the garbage carts for incineration near the dumps.

"(4) Paper, house-sweepings, etc., were collected in large drays. The paper and other dry refuse was used to fill land.

"(5) A third corps was engaged in collecting and disposing of the offensive accumulations, other than garbage, which had gathered in streets and alleys. The force consisted of high-bodied coal drays of 36 cu. ft. capacity, and laborers provided with hoes and shovels. The drays and laborers were divided into gangs; three laborers to one dray, and from two to four drays to one gang, afforded the most satisfactory results. With a haul of 3 1-3 miles, and an average of 8 1-3 loads per day, the cost of scraping and removing this material was 67.3 cts. per cu. yd.

"(6) A small corps of sanitary inspectors was put to work in the various districts. Its duty was to visit private premises for the purpose of inspecting the condition of yards and outhouses, to give sanitary advice, and if necesary to serve board of health notices that householders would be required to put their property in satisfactory order within a brief period. The men had note-books in which the conditions found were recorded and reported to me at the close of each day.

"(7) There was a force of carts and men detailed to distribute disinfectants. Lime, carbolic acid, sulphate of iron and creolin were used in places from which objectionable matters were taken. Stagnant gutters, foul-smelling alleys, and private and public outhouses frequently received such treatment before it was expedient to clean them out. For work of this kind, unslaked lime, distributed as generally as possible over the offensive area, was found useful. A saturated solution of copperas was occasionally employed to arrest decomposition. Creolin, mixed with water, was used in a watering cart employed to sprinkle streets in the business portion of the city. The watering cart held about 600 gallons, and to nearly this quantity of water half a barrel of creolin was added. A stronger mixture would have been desirable, but would have probably caused complaint from pedestrians. The creolin produced an agreeable counter odor to the emanations from the gutters, and appreciably reduced the number of flies in the streets which were sprinkled. Crude carbolic acid was used with good effect in treating stagnant pools of water which were offensive because of decomposing organic matter contained by them. Whenever possible, shallow pools were drained off or filled with dry sand, broken bricks or shells. If very shallow, a thorough raking facilitated an absorption of the water by the soil. Special directions were given in all cases to use disinfectants in such a way that they might reach all the particles of the offensive substances to be treated.

"It was necessary to dispose of the bodies of dead persons and animals by burning and by burial, and circumstances usually required that this should be done close to the place where the bodies were found. Owing to the fact that the ground water in Galveston lies within a few feet of the surface of the ground, burning was the method of disposal generally followed. The bodies were placed upon large bonfires which were kept burning until the remains were consumed. Where burial was necessary, it was found desirable to use quicklime in the trenches."

Five hundred blocks of streets, alleys, and gutters were cleaned and more than 2,000 cubic yards of decomposing refuse

were removed in less than two weeks. Regular collection of refuse was established. The indifference and inattention of the people to sanitary regulations were largely overcome, and they were led to aid the work of the department. None of the dreaded epidemic diseases gained a foothold.

Mr. Soper, upon his departure from Galveston, at the request of a committee of physicians made a series of suggestions for continuing the work. These were substantially: Careful observance and enforcement of health ordinances; regular collection and disposal of refuse; assignment of a special force to the correction of particularly bad local conditions; final disposal of all wreckage by burning; careful watch for and isolation of infectious diseases; continuance of the ordinary arrangement for street cleaning and night-soil removal; cleaning of streets and gutters from obstructions, and direction of liquid wastes into sewers, rather than into the streets, so far as possible; examination, cleaning, and flushing of sewers.

The Lawrence Filter Plant.

THE Lawrence filter was not the first sand-filtration system installed in the United States, but for some years it was the best known—partly because (until the Albany filter was built) it was the largest, partly because its active and enlightened management made it a kind of school of water purification whose disciples spread its traditions wherever they went. Follow back the career of the able men now engaged in the field of public water supply in the United States, and it will in a very great number of cases lead to Lawrence. The historical review of the installation and maintenance of the filter which Messrs. Morris Knowles and Charles Gilman Hyde present before the American Society of Civil Engineers has therefore an interest warranting notice, even though the Lawrence plant has long been surpassed in importance by the newer and larger filters at Albany, Pittsburg and Philadelphia. The paper, as explained in the introductory paragraph, was undertaken "in order that the story of this interesting engineering work, and, particularly, an account of its operations, might be recorded in one narrative with all necessary data at hand for a study of conditions and effects produced thereby." To this end the paper is accompanied by a remarkably full set of tables, with diagrams and photo-engravings giving exact and definite knowledge of the plant, its operation, and its results. Only a very brief summary can be attempted here.

The city is seventh in population in the State of Massachusetts, compactly built on an area of about 7 square miles, on the banks of the Merrimac. The population has grown from 3,577 in 1847 to 62,559 in 1900. It is a distinctively manufacturing city, characterized throughout by hygienic conditions rather above the average. The watershed of the Merrimac, mountainous in its upper portions, lower down is flat and sometimes swampy. Its total area above Lawrence is estimated at 4,630 square miles, on which is a population of about 500,000. The tributaries have been developed for water power, and the attendant manufacturing wastes are turned into the stream. The State Legislature in 1878 made the Merrimac a free receptacle for sewage, and Mr. Hiram F. Mills estimated the sewage entering the river during the period 1887-1890 at 1 gallon to every 600 gallons; in 1900 it is estimated at 1 gallon to 40 gallons in the driest times, or 1 gallon in every 200 gallons of the average flow. Usually, the water at the Lawrence intake shows only about 10 parts per million of suspended matter; in April, 1895, during a severe freshet, it was found to carry 1,110 parts per million, of which 57 parts represented organic matter lost on ignition. The material settles rapidly, so that in a few days after a severe freshet the water reassumes its normal character.

When the water works were constructed in 1873-1876, water was taken directly from the river through an iron and brick conduit to a well under the pumping station, and further provision for clarified water was made by construction of a stone and brick filter gallery, 8 feet in width and height, and 300 feet long, with its bottom level 11 feet below usual low water, extending down stream at right angles with the direct intake. The water from the gallery was to be used when the river was carrying an undesirable amount of suspended silt, but when it was built it was uncertain that

a full supply for all time could be secured through this gallery. In the first annual report of the Water Board, Jan. 1, 1877, it was stated that sufficient water would not percolate, and an excavated channel between the structure and the river was necessary. The channel was enlarged in 1878. By 1883 it became manifest that the gallery was silting up, most of the water coming from the land side, which source was quite inadequate and indeed inconsiderable in comparison with the city's consumption. Typhoid, following the appearance of the same disease up stream, rose to excessive extent in 1890. A conference in 1891 led to better understanding of the need of improved water supply, but developed a diversity of opinion as to whether filtered Merrimac water or a new supply from uncontaminated ponds in New Hampshire should be used. A very broad charter granted the Salem Water Company put obstacles in the way of the latter project; Mr. Mills' experiments, in a long series beginning in 1886, had demonstrated that intermittent sand filtration would render the Merrimac water entirely satisfactory and safe; and on June 22, 1891, the water board recommended to the city councils that the use of Merrimac water be continued, but that it be filtered, the system of filtration to be determined later. In February, 1892, the advice of the State Board of Health was asked; they felt unable to advise any of the rapid mechanical filters then in use, but they did advise that by slow intermittent filtration at the rate of 400,000 gallons per acre per day, bacteria could be very completely removed. In June of the same year they advised the Lawrence water board that with sand filters of proper materials 5 feet deep, 1,500,000 gallons per acre per day could be filtered with resultant satisfactory purification, but that it would be necessary to free the river water from excessive sediment during freshets before applying it to the filters, which could be located conveniently on the hill above the reservoirs. A coarse-sand filter on the river bank would accomplish the preliminary clarification, and even of itself markedly decrease the death-rate—and the excessive mortality from typhoid demanded the immediate adoption of some method of purifying. The water board concluded that a filter on the river bank presented the more feasible project, and "decided to proceed with its construction according to plans and directions to be given by the State Board of Health."

Ground was broken on September 10th, and after some vacillation on the part of the city councils, due to uncertainty as to the promised action of the filters, the filter was completed September 20, 1893, at a cost of $65,000, and has continued to furnish the city with filtered water to the present time.

It is somewhat irregular in outline, extending along and beyond the old filter gallery to a length of about 750 feet, with an average width of about 150 feet and an available filtering surface of 2.36 acres. It is divided by transverse carriers into twenty-five portions, or beds, each with an average width of 30 feet. Each of these beds is a shallow valley, with a flat bottom five feet wide, and sloping sides rising 1 in 10 to a five-foot intervening ridge. The bottom of the filter, as excavated to receive the filtering material, was thus waved, with flat valleys in which the underdrains were placed and low ridges between. The underdrains deliver to the old gallery or the main conduit extended from it. The underdrains were covered first with 4 to 6 inches of 2-inch gravel, upon which were spread successively 2 inches of 1½-inch gravel, and 1 inch each of ¾-inch, ⅜-inch, and 3/16-inch gravel and 1 inch of coarse mortar sand. The courses each spread out a little beyond the one below, until the last course was spread out to a width of 20 feet. Over the center lines of the underdrains, extending 5 feet each side, was placed a body of .25 mm. sand 5 feet deep in the center; over the intervening ridges, extending 10 feet each side, was placed a body of .30 mm. sand 3 feet deep in the center.

The depth customarily maintained is one foot over the crowns of the bed. The more slowly the process is conducted, the smaller will be the amount of entrained air and the less the loss of head. Undue haste in filling actually causes loss of time. When the filter becomes clogged, the inlet water is shut off, pumping is maintained at a constantly decreasing rate, and when the water in the beds has passed sufficiently below the surface for laborers to work, the clogged surface is scraped off with shovels, wheeled away in barrows, the surface raked and

smoothed, and the filter again put in service. The scraped-off sand is washed, and dumped over a paved slope ready for replacement on the filter.

The total cost of maintenance reached $9 per million gallons in 1897, but for 1899 and 1900 was only $7.70 per million; this includes removal of snow and ice, the removal of which costs about $2 per million gallons. The efficiency, as shown by averages of six years (1893-1899) is indicated by the removal of 11.6 per cent. of the color, 3.4 per cent. of the free ammonia, 52.8 per cent. of the albumenoid ammonia, 50 per cent. of the nitrites, and about 98.9 per cent. of the bacteria. It is impossible, however, to do justice to the statistical portion of the paper in the space of a review. The details of operation and efficiency are presented in admirable fulness and clearness, and those particularly interested in the subject can follow them to satisfaction and profit in the original paper.

Submarine Cables.

In a review of the cable systems of the United States and Great Britain, by Captain George O. Squier, U. S. A., which has recently appeared in the *National Geographic Magazine*, the author naturally lays particular stress upon their military importance, but his paper is also of general commercial and engineering interest.

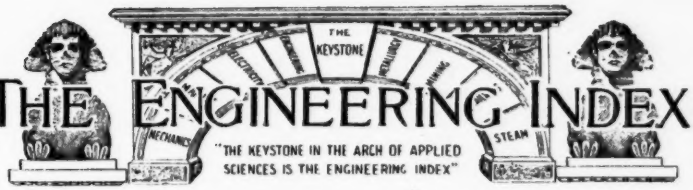
He says that the history of the Spanish-American war "is largely a story of 'coal and cables.' That war for the first time demonstrated the dominating influence of submarine cable communications in the conduct of a naval war, and as a result of it the principal maritime powers with colonial possessions are at present elaborating their 'cable policy.'" Germany has already laid an independent cable to the United States, touching only at the Azores, and is contemplating the establishment of a cable network covering her own possesions and Holland's in the East. France intends to have an "all-French" system connecting her with all her colonies, but at present no submarine cable system can be compared with Great Britain's, which binds the whole Empire "together in one vast intelligence transmission system, with London at its center.

"An essential and necessary condition which has guided in the conception and realization of this cable system has been that none of the lines shall touch foreign soil." In the proposed British-Pacific cable, this principle is responsible for the unprecedentedly long span of 3,500 nautical miles from Vancouver to Fanning Island, which will place this cable at a permanent commercial disadvantage with those of shorter spans.

The United States, though more favorably situated in the matter of way stations across the Pacific, will also be guided by political considerations in laying their first cable to the Philippines. Judged solely from a commercial and technical point, a cable by way of Alaska, the Aleutian Islands and Japan possesses many advantages. The spans would be much shorter, the cable would be laid in comparatively shallow waters, and there would be a considerable and developable local traffic. But it will be necessary for political and military reasons to connect the advance posts in the Pacific with the States, and to have a cable entirely under American control in war as well as in peace. Perhaps the best solution of the matter will be to lay cables by both the Hawaiian and Alaskan routes, one serving as a duplicate for the other. Captain Squiers believes that it will be necessary to connect Porto Rico directly to the United States by cable, and he gives an estimate of the cost as follows:

Trans-Pacific cable via Hawaii and Guam, $12,000,000; Hawaiian inter-island system, $150,000; Philippine inter-island system, $250,000; Alaska telegraph system, $450,000; Trans-Pacific cable via Alaska and Alaskan cable system, $10,000,000; Tutuila Island to the British station at Fiji, $650,000; United States to Porto Rico, $1,500,000. "This estimate, which is necessarily a very general one, shows that with an expenditure of $25,000,000, or perhaps $30,000,000 at most, the United States can have a telegraph system connecting all their possessions, and they will be wise if they pursue a broad, vigorous and even lavish 'cable policy.'

"The cable question is one of the most important of the present hour, unique in that American commerce, diplomacy and seapower—in fact the most efficient means of advancing and securing the benefits of civilization itself—happily conspire in demanding its early solution."



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Genie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Arch.

The Riverside Cemetery Bridge, Cleveland. Illustrated description of a light two-hinge arch bridge of 142 ft. span, designed to harmonize with park-like surroundings. 700 w. Eng Rec—April 20, 1901. No. 40358.

Bascule.

Page Bascule Bridge Over the Chicago River at Ashland Ave. Illustrates and describes two designs on the Page system, one a high-truss and the other a low-truss design. 3000 w. Eng News—April 25, 1901. No. 40569.

The Ashland Avenue Bascule Bridge, Chicago. Illustrated description of a two-leaf structure with about 150 ft. clear span, operated by gears which are driven by electric motors, and meshed into racks on the top chord of the shore end leaf. 2100 w. Eng Rec—April 27, 1901. No. 40581.

Bearings.

Adjusting the Bearings of Long and High Bridge Spans. Describes methods of repairing roller bearings by wedging the shoes so as to free the rollers. 800 w. Eng Rec—April 13, 1901. No. 40301.

East River.

Construction of the New East River Bridge. Considers the cables and roadway, giving illustrations. 1300 w. Sci Am—April 20, 1901. No. 40351.

Erecting the End Spans of the New East River Bridge. Illustrated description of heavy high false work and travelers and their use in erecting spans of 300 ft. each. 2000 w. Eng Rec—April 27, 1901. No. 40583.

The Suspended Structure for the New East River Bridge. Illustrated description of this part of the work, comprising the stiffening trusses, transverse bracing and floor framing, giving specifications for material and workmanship. 2000 w. Eng News—April 18, 1901. No. 40376.

Highway Bridges.

Contracting for Highway Bridges. A statement of the reasons for the inadequacy of many structures comparatively new, with suggestions on the best methods of securing new bridges. 1200 w. Eng Rec—April 27, 1901. No. 40577.

Highway Bridge Contracts. R. H. Phillips. A discussion of the reasons for poor highway bridge work, with suggestions for improvements in the award of contracts. 2100 w. Eng Rec—April 20, 1901. No. 40357.

Melan Arch.

Melan Arch Bridges Over Fall Creek, Indianapolis, Ind. Illustrated description of two concrete-steel bridges of the Melan type, recently constructed. 1100 w. Eng News—April 11, 1901. No. 40274.

Reconstruction.

Reconstruction of the Missouri River Bridge at Glasgow, Mo.; Chicago & Alton Ry. W. D. Taylor. Describes the old bridge and the new, giving an account of the interesting features of the construction work. Ill. 3000 w. Eng News—March 14, 1901. No. 40340.

Specifications.

General Specifications for Railway Bridges in North America (Grundzüge für die Berechnung und Construction der Eisenbahnbrücken in Nordamerika). Prof. J. Melan. An abstract of the general specifications for steel bridges recently issued by the American Bridge Co. 2400 w. Zeitschr d Oesterr Ing u Arch Ver—April 5, 1901. No. 40436 B.

Wooden Bridge.

Bridge Over the Macleay River, New South Wales. Illustrated description of a structure with spans much longer than any hitherto attempted in the Australian colonies. 800 w. Engr, Lond—March 29, 1901. No. 40245 A.

CANALS, RIVERS AND HARBORS.

Bristol, Eng.

The Port of Bristol. An account of the proposed improvements in docks, with a review of the history of this port. Maps. 4500 w. Builder—March 30, 1901. No. 40221 A.

Canada.

The Soulanges Canal Works, Canada. C. R. Coultée. The present article gives an illustrated description of the place, profile and cross-section, guard lock, culverts, draw bridges, locks, etc., of a canal representative of modern hydraulic engineering of this class. 4800 w. Eng News—April 18, 1901. Serial. 1st part. No. 40373.

The Water Ways of Canada. Concerning the unrivaled rivers, lakes, and canals, the traffic, revenue, etc. 2300 w. U. S. Cons Rept's, No. 1013—April 17, 1901. No. 40326 D.

Chicago Canal.

Expert Commission's Plans for Increasing the Flow Through the Chicago Drainage Canal. Explains the two plans submitted, and a summary showing their conclusions and the manner in which they have been reached. 1400 w. Eng News—April 4, 1901. No. 40150.

We supply copies of these articles. See introductory.

Dredges.

The Maintenance of Centrifugal Dredging Pumps. A statement of the results of experience with the hydraulic dredges of the Mississippi River Commission. 1000 w. Eng Rec—April 20, 1901. No. 40361.

Dry-Dock.

Construction of the New Dry-Dock at the Skinner Shipyard, Baltimore. Plans and sectional drawings showing the methods of construction, with an account of the difficulties which have been met in the work. 1200 w. Marine Engng—April, 1901. No. 40211 C.

Floods.

Increasing Height of Floods in the Lower Mississippi: the Problem and Its Solution. L. W. Brown. Slightly condensed from a paper read before the Louisiana Engng. Soc. A statement of facts and a discussion of the cause and the remedy. 5300 w. Eng News—April 18, 1901. No. 40375.

Harbor Improvement.

Description of Coos Bay, Oregon, and the Improvement of Its Entrance by the Government. William W. Harts. Description of the north jetty and the conditions prior to the commencement of operations, methods used, etc. Ill. 8000 w. Pro Am Soc of Civ Engs—April, 1901. No. 40523 E.

Final Report of the Dynamiting of the Brunswick Outer Bar, Ga. Information concerning the work and the cost. 1400 w. Eng News—April 18, 1901. No. 40378.

Hydro-Electric Station.

The Sarpsfos Hydro-Electric Station in Norway (La Station Hydro-Electrique de Sarpsfos, Norwège). A. B. An article from the *Zeitschrift für Bauwesen*, giving an illustrated description of this plant, which will ultimately develop 24,000 H. P., and transmit part of it long distances. 1200 w. Génie Civil—March 23, 1901. No. 40443 D.

Inclined Planes.

Austrian Canal Projects From a Mechanical Engineering Standpoint (Unsere Canal-Projecte vom Standpunkte der Oesterreichischen Maschinen-Industrie). Victor Schönbach. A general review of some Austrian canal projects and the proposed inclined-plane lifts. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—April 6, 1901. No. 40439 D.

Irrigation Pumping.

Electric Power for Irrigation Pumping at Bakersfield, California. Illustrated description of an interesting irrigation system. 2200 w. Elec Wld & Engr—April 6, 1901. No. 40206.

Madagascar.

The Canal of the Pangalanes, Madagascar (Le Canal des Pangalanes, Madagascar). J. H. Delaunay. A description, with maps and illustrations, of a waterway along the east coast of Madagascar, from Tamatave southward, forming part of a route to the capital, Tananarive. 1 plate. 2500 w. Mem d l Soc d Ing Civils—February, 1901. No. 40470 G.

Nicaragua Canal.

Volcanic Conditions on the Line of the Nicaragua Canal. Extracts from lectures of Mr. Bunau-Varilla, a distinguished French engineer, on the probability of volcanic disturbances. 1000 w. R R Gaz—April 26, 1901. No. 40571.

Nile.

Improvements on the Nile. Sketch of the present state of the work on the Assouan Dam, and other work directly connected therewith, with statements of the benefits contemplated. 4000 w. U. S. Cons Repts, No. 1019—April 24, 1901. No. 40397 D.

Sea Walls.

The Delaware Avenue Improvement, Philadelphia. Illustrated description of heavy concrete and timber sea walls about one-mile long; the method of making concrete blocks and setting them on pile foundations is described in detail. 3000 w. Eng Rec—April 20, 1901. No. 40355.

Water Rights.

Water-Power Plants in France (Les Usines Hydrauliques Publiques). Dr. Louis Rachou. A criticism of the French law governing the development of water-power on rivers in France. 2000 w. Génie Civil—April 6, 1901. No. 40450 D.

CONSTRUCTION.

Building Construction.

The Additions to the Mutual Life Building, New York. Illustrated description of the complicated cantilever foundation girders and wall columns in a high office building. 2500 w. Eng Rec—April 6, 1901. Serial. 1st part. No. 40179.

Building Failures.

The Court of Final Resort of New York on the Failure of the Ireland Building. Full text of a decision exonerating from blame the owner of a building which fell during construction on account of improper foundations for columns. 3060 w. Eng Rec—April 20, 1901. No. 40365.

Compressed Air.

Observations on Compressed Air Illness. Frederick R. Wainwright, in *The Lancet*. On the effects from prolonged working in compressed air and the treatment of recompression. 11500 w. Compressed Air—April, 1901. No. 40231.

Engineering Building.

The New Steam Engineering Building for the Brooklyn Navy Yard. Illustrated

description of structural details of the new shop buildings being constructed. 1100 w. Eng News—April 25, 1901. No. 40564.

Fireproofing.

An Attempt to Devise a System of Absolute Fireproofing for Interior Steel Construction. Description, with illustrations of the latest improvements of the U. S. Clay Mfr. Co., and their adaptation in detail to buildings. 1200 w. Br Build—April, 1901. No. 40588 D.

Foundations.

Analysis of Pressure on Foundations of Buildings. Letters from John H. Gregory and F. E. Robertson. Gives solutions for determining the intensities of pressures on the footing course of a building wall. Ill. 1500 w. Eng News—March 14, 1901. No. 40338.

Grain Elevator.

New Steel Elevator at West Superior. Illustrated description of a great grain-holding structure of steel at the head of the Great Lakes. 3000 w. Ir Trd Rev—April 18, 1901. No. 40354.

The Largest Steel Grain Elevator. Illustrated detailed description of an elevator just completed at the head of Lake Superior. 3300 w. Ir Age—April 25, 1901. No. 40531.

Luxfer Prisms.

Luxfer Prisms, and Prismatic Lighting Theory and Application. R. A. Wood. Reviews the laws of refraction and reflection of light, on which these prisms are based, and how to determine what prisms to use. 4500 w. Builder—April 6, 1901. No. 40316 A.

Moving Buildings.

Moving and Underpinning Buildings. Illustrated description of methods employed in raising, lowering and underpinning timber, brick and stone buildings in Pittsburg and vicinity. 3000 w. Eng Rec—April 27, 1901. No. 40584.

New York Subway.

Sections 11, 13 and 14, New York Rapid Transit Railway. Illustrated description of method of constructing double-track concrete subway, partly in open cut and partly in rock tunnel. 1600 w. Eng Rec—April 13, 1901. No. 40302.

Roads.

Construction and Care of Earth Roads in Illinois. Ira O. Baker. Extract from a bulletin issued by the Illinois Agricultural Experiment Station. 3700 w. Eng News—April 18, 1901. No. 40377.

Recent Road Construction in Massachusetts. A review of the report of the State Highway Commission, describing the method of building various classes of highways, and of keeping them in repair. 2100 w. Eng Rec—April 6, 1901. No. 40175.

Road Maintenance in New Jersey. A statement of a method of maintaining roads by continuous rather than general repairs. 2200 w. Eng Rec—April 20, 1901. No. 40360.

Specification for Tarred Macadam Roadways. From a pamphlet issued by the National Coal Tar Co., of New York. Gives proposed specifications for grading, foundation, wearing surface, tar, etc. Also specification of Hamilton, Ont. 3300 w. Pro Age—April 1, 1901. No. 40124.

Roof Trusses.

Reinforcing and Replacing Church Roof Trusses. Illustrated description of the method of taking down 60-ft. timber trusses destroyed by dry rot, and replacing them with steel work without injuring a plaster ceiling suspended from the old trusses. 1000 w. Eng Rec—April 20, 1901. No. 40363.

Skeleton Construction.

The Steel Skeleton Construction of a Tall Office Building. J. S. Branne. An illustrated description of the construction; how the steel work is planned for a certain width, length and height of a building, etc., so as to combine strength and economy. 8000 w. Jour Assn of Engng Socs—Feb., 1901. No. 40132 C.

Spacing Rivets.

A Direct Method of Spacing Rivets and Finding the Position, etc., of Stiffeners in Plate Girders. E. Schmitt. Discussion of this paper continued from February, 1901. 5000 w. Pro Am Soc of Civ Engs—April, 1901. No. 40525 E.

Steel Buildings.

Steel Buildings for Export. H. G. Tyrrell. Illustrated description of designs, giving approximate cost of material and shipping. 2400 w. Eng News—April 11, 1901. No. 40275.

Tunnels.

Notes on Tunnel Work, Japanese Government Railways. Information taken from the annual report of the Imperial Government Railways on difficulties encountered in tunnel work. 1000 w. Ry & Engng Rev—April 13, 1901. No. 40290.

Sewer Tunneling in Fine Sand in Brooklyn. Illustrated description of the heavy timbering required for a 3½ ft. brick sewer in running sand. 1900 w. Eng Rec—April 27, 1901. No. 40578.

The East Boston Tunnel Extension of the Boston Subway. Illustrates and describes the essential features of the work of constructing a tunnel under the harbor. Also editorial. 4600 w. Eng News—April 4, 1901. No. 40148.

The Kellogg Tunnel, Bunker Hill and Sullivan Mines, Idaho. Ulysses B. Hough. An illustrated account of the tunnel constructed for the purpose of developing

mines, the aim from the outset being to make the greatest possible progress. 1200 w. Eng News—April 25, 1901. No. 40568.

The Re-lining of the Coudray Tunnel. Illustrated description from *Centralblatt der Bauverwaltung*, of a traveling steel center permitting the passage of trains and enabling workmen to tear out and rebuild a tunnel arch. 700 w. Eng Rec—April 20, 1901. No. 40362.

MATERIALS.

Cement.

Cement and Mortar Testing. A discussion of the different purposes of neat and sand tests of cement. 1000 w. Eng Rec—April 6, 1901. No. 40173.

Concrete.

The Revised Concrete Specifications of the New York State Canals. An outline of requirements which permit balancing the aggregate, call for machine mixing except in small work and give minute directions for placing the concrete in molds. 1400 w. Eng Rec—April 27, 1901. No. 40580.

Forest Restoration.

Pennsylvania Forests and What Is Necessary to Their Restoration. Joseph T. Rothrock. Considers the forests as they were, are, and ought to be, and what is necessary to bring about the desired condition. Also discussion. 10000 w. Pro Engrs' Club of Phila—April, 1901. No. 40527 D.

Reinforced Concrete.

Brick and Concrete Metal Construction. Papers presented at the October meeting of the Boston Soc. of Civ. Engs. Deals with the economy, strength, various uses, etc., reviewing the systems. Ill. 6000 w. Jour Assn of Engng Socs—Feb., 1901. No. 40131 C.

Computing the Strength of Concrete Steel Beams. A simple mathematical discussion on beams built of these materials. 700 w. Eng News—April 25, 1901. No. 40567.

MEASUREMENT.

Surveying.

Primary Triangulation and Precise Levels of the United States Government Surveys. Herbert M. Wilson. An explanation of the work done by the government surveying organizations. 3000 w. Eng News—April 4, 1901. No. 40152.

Variations and Uses of the Standards of Measurements Employed in Field Engineering. Benjamin Franklin. Discusses the differences in standard and the mechanical inaccuracies. 4800 w. Pro Engrs' Club of Phila—April, 1901. No. 40529 D.

MUNICIPAL.

Asphalt Plant.

The Municipal Asphalt Plant at Winnipeg, Man. Description with information concerning cost of plant, maintenance, material, labor, etc. 1400 w. Eng News—April 11, 1901. No. 40277.

Galveston.

The Sanitary Cleaning of Galveston After the Great Storm of 1900. George A. Soper. Extract from a report made to the Chamber of Commerce of the State of New York, on the general plan, organization, and results. 1800 w. Eng News—April 25, 1901. No. 40565.

Navy Memorial.

A Water Gate for New York. A description of the design prepared by Ernest Flagg, for a memorial to be erected in Battery Park. Also editorial. 2000 w. Stone—March, 1901. No. 40282 C.

Pavements.

Coal Tar for Paving Uses. Fred. J. Warren. Tells what coal tar pitch or cement is, and the uses to which it has been applied. 1700 w. Munic Engng—April, 1901. No. 40105 C.

Expansion in Brick Pavements. Daniel B. Luten. Discusses the causes of the rumbling sounds produced by brick pavements under traffic, especially during the heat of summer; considers it due to expansion, and suggests the remedy. Ill. 800 w. Eng News—March 14, 1901. No. 40339.

The Economic Value of Paved Roads. Halbert-Powers Gillette. A letter discussing the arguments of Prof. I. O. Baker, and giving the writer's views, with editorial reply. 3500 w. Eng News—April 11, 1901. No. 40280.

Wood Paving in London. Gives the standard specification for laying wood paving, with remarks. 700 w. U. S. Cons Repts, No. 1021—April 26, 1901. No. 40544 D.

Sewage Disposal.

Septic Tanks, Pump Wells, and Filter Beds of the Draper Co., Hopedale, Mass. Leonard Metcalf. Illustrated description of an interesting plant for disposal of the sewage and wastes of a large plant for the manufacture of cotton machinery. 2000 w. Eng News—April 25, 1901. No. 40563.

The Septic Tank at Marion, Iowa. Illustrated description of the concrete septic tank of a city of 4,200 population, the septic effluent being discharged directly into a small brook. 1400 w. Eng Rec—April 6, 1901. No. 40177.

The Shone Sewerage System and Bacterial Beds at Hampton, England. Describes a system where all the sewage is pumped by compressed air and purified by contact beds and land treatment. The

latter was required by the Local Government Board and effects no purification of the effluent from the beds. 1600 w. Eng Rec—April 27, 1901. No. 40586.

Sewerage.

Sewer Maintenance in Columbus, Ohio. George W. Lilly. Read before the Engrs' Club of Columbus. Illustrated paper on the methods and cost of cleaning catch-basins, manholes and sewers. 4600 w. Eng Rec—April 27, 1901. No. 40582.

The Sewerage of Nahant, Masaschusetts. E. W. Bowditch. Illustrated description of the separate sewerage system, and means taken to prevent further soil pollution. 1800 w. Dom Engng—April 15, 1901. No. 40344 C.

Street Cleaning.

City Cleansing in New York. Charles A. Meade. Sketch of the work of the street-cleaning department for the past six or eight years. It not only sweeps the streets, but collects and disposes of all refuse. 7300 w. Munic Af—Dec., 1900. No. 40249 D.

Methods of Cleaning Pavements. H. C. Innes. Deals principally with the cleaning of asphalt pavements and the appliances used. 2000 w. Munic Engng—April, 1901. No. 40104 C.

Street Cleaning in St. Paul. A description of the methods of cleaning different classes of pavement by machine and by hand. 1000 w. Eng Rec—April 13, 1901. No. 40304.

WATER SUPPLY.

Electrolysis.

Notes on the Electrolysis of Water Pipes. Illustrated description of damaged 48-inch pipes in Cambridge, Mass., with abstract of remarks made by A. A. Kundson before the N. E. W. W. Assn., on recent aspects of electrolysis. 1400 w. Eng Rec—April 6, 1901. No. 40176.

See Electrical Engineering, Measurement, and Gas Engineering.

Filtration.

The Lawrence, Mass., City Filter: A History of Its Installation and Maintenance. Morris Knowles and Charles Gilman Hyde. An account of this engineering work and its operations, that all the necesary data may be in form for reference and study. Ill. 17900 w. Pro Am Soc of Civ Engs—April, 1901. No. 40-524 E.

The Upper Roxborough Filter Plant at Philadelphia. Illustrated description of a covered filter plant of 2,100,000 gallons daily capacity, with covered filtered-water basin, all the structures being of concrete. 1800 w. Eng Rec—April 13, 1901. No. 40299.

Flow.

Flow of Water in Pipes. Clinton B. Stewart. Considers briefly the nature of fluid friction, general formulas, and a diagram for use in the design of distributing systems. 1800 w. Eng News—April 11 1901. No. 40278.

Outflow of Water from Tanks or Reservoirs. Considers the time of flow of a given quantity of water through an orifice. 1300 w. Engr, Lond—April 12, 1901. No. 40516 A.

Laboratory.

The Mount Prospect Laboratory, Brooklyn, New York. Describes a station for chemical, bacterial and microscopical analysis of the complicated Brooklyn water supply. 3000 w. Eng Rec—April 13, 1901. No. 40300.

New York.

The Department of Water Supply. William F. King. Information concerning the comparative cost and utility, organization and administration, revenue, etc. 3500 w. Munic Af—Dec., 1900. No. 40250 D.

Paris.

The Water Supply of Paris. Abstract of an article in *Le Génie Civil*, giving much interesting information. Ill. 1500 w. Eng News—April 4, 1901. No. 40151.

Spring Water.

An Investigation of Spring Water (Nouvelle Méthode d'Etude des Eaux de Sources). Félix Marboutin. An account of the very complete investigation, topographical, geological, chemical and bacteriological, made of some sources of the Paris water supply by a commission, with maps. 1 plate. 8500 w. Mem d l Soc d Ing Civils—Feb., 1901. No. 40475 G.

Water Consumption.

The Effect of Water Meters on Water Consumption in the Larger Cities of the United States. George I. Bailey. Information of importance collected and tabulated, with editorial comment. Shows the average per capita daily consumption to be 137 gallons. 3200 w. Eng News—April 18, 1901. No. 40374.

Water-Works.

Water-Works in the Madras Presidency. An explanation of the requirements which led to special methods of design and construction of systems for Indian towns. 2200 w. Eng Rec—April 20, 1901. No. 40359.

MISCELLANY.

Antarctica.

Antarctica: A History of Antarctic Discovery. Edwin Swift Balch. A review of what has been accomplished in antarctic exploration. 6200 w. Jour Fr Inst—April, 1901. Serial. 1st part. No. 40-157 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchanges.

Room for Improvement in Telephone-Exchange Management. R. M. Lockwood. Discusses some of the customs that irritate customers, and urges that the good will of subscribers is of more importance than quickness of service. 2500 w. W Elect'n—April 6, 1901. No. 40216.

Pacific Coast.

The Development of the Telephone on the Pacific Coast. Discusses the causes of the rapid development. Ill. 1700 w. Elec Wld & Engr—April 20, 1901. No. 40392.

Printing Telegraphs.

The Applications and Requirements of a Printing Telegraph. Romyn Hitchcock. From the *Telegraph Age*. Gives reasons why the printing telegraph operated from a key-board can never compete with the Morse key for general service, and discusses the requirements and the subject in general. 2800 w. Elec, N. Y.—April 24, 1901. No. 40543.

The Baudot Multiplex Printing Telegraph (Der Mehrfach-Typendrucker von Baudot). Hr. Grallert. A paper before the German Elektrotechnischer Verein, giving a very complete, illustrated description of this system now in use between Berlin and Paris. 12000 w. Elektrotech Zeitschr—March 28, 1901. No. 40426 B.

Space Telegraphy.

The Marconi-Dolbear Infringement Suit. E. Frederick Collins. An account of this legal controversy, giving a comparison of the theoretical claims and construction of the apparatus. 1600 w. Elec Wld & Engr—April 13, 1901. No. 40288.

The Oudin Bipolar Resonator.—Wireless Telegraphy (Le Resonateur Oudin Bipolaire.—La Télégraphie sans Fils). M. O. Rochefort. An article describing, first, an electro-therapeutic apparatus, and, second, a space telegraphy system, with various details. Ill. 1 plate. 3800 w. Mem d l Soc d Ing Civils—Feb., 1901. No. 40476 G.

The Part Played by the Antenna in Wireless Telegraphy. E. Guarini and F. Poncelet. In the opinion of the writers the part played by the antenna is deduced from the mode of propagation of the electro-magnetic wave. The subject is discussed and conclusions stated. 2000 w. Elec Rev, Lond—April 5, 1901. No. 40323 A.

Wireless Telegraphy (Ueber Drahtlose Telegraphie). Prof. F. Braun. A description, with diagrams, of the author's method, in which the oscillations in his sending wire are excited through an induction coil, instead of directly; and a comparison of his method with Marconi's. 1500 w. Elektrotech Zeitschr—March 21, 1901. No. 40422 B.

Submarine Signaling.

Submarine Signaling. A description of the system devised by Arthur J. Mundy and Prof. Elisha Gray, which has been recently tried in Boston harbor. 2000 w. Marine Rev—April 25, 1901. No. 40557.

Telephone Service.

Telephone Service Ideals. G. F. Jenks. Considers the ideal will only be reached when every business man has a telephone on his desk, and every house has a telephone in every room, and when all these telephones can readily communicate. 1300 w. Elec Wld & Engr—April 20, 1901. No. 40396.

Telephone-Telegraph.

Telephony on Telegraph Circuits (Anschaltung von Fernprechsystemen an Morseleitungen). O. Cantor. A short description of an arrangement by which telephoning is carried on over Morse telegraph circuits. Diagrams. 400 w. Elektrotech Zeitschr—April 4, 1901. No. 40429 B.

DISTRIBUTION.

Alternating Currents.

Alternating Current Systems. H. S. Meyer. The present article discusses the advantages and disadvantages of high frequency and other points bearing on the selection of the best suitable frequency for a system. 1800 w. Engng—March 29, 1901. Serial. 1st part. No. 40235 A.

Alternating vs. Continuous.

On the Relative Advantages of Alternating and Continuous Current for a General Supply of Electricity, Especially with Regard to Interference with Other Interests. A topical discussion at the joint meeting of the American and British societies at Paris, 1900. 12000 w. Trans Am Inst of Elec Engs—March, 1901. No. 40554 D.

Dielectric Losses.

Dielectric Losses in Condensers and Cables and Their Bearing on Electrical Supply. Charles V. Drysdale. Gives a summary of the advantages and disadvantages of polyphase as compared with single-phase systems, and an account of tests made on cables and condensers. 2500 w. Elect'n, Lond—April 5, 1901. No. 40319 A.

Equalizers.

Equalizer Circuits (Ausgleichleitungen).

Prof. J. Teichmüller. A paper before the Verband Deutscher Elektrotechniker, containing a theoretical discussion and a practical example of the equalization of the potential in distributing networks, with diagrams. 3 parts. 8500 w. Elektrotech Zeitschr—March 14, 21, 28, 1901. No. 40415 each B.

Manchester.

Manchester Electricity Works. An illustrated description of the three-phase extensions put down as a temporary aid to the low-pressure system of distribution, and also of the present system of supply. 4000 w. Elec Engr, Lond—April 5, 1901. No. 40317 A.

Periodicity.

Some Notes on Changes of Periodicity. States the advantages of the reduction of the periodicity to the lowest possible value, with remarks on a change from 100 periods to 50 periods, but also applicable to changes of a lesser degree. 1500 w. Elec Rev, Lond—April 5, 1901. No. 40325 A.

Poles.

Holding Capacity of Anchors for Electric Wiring Poles. R. C. Carpenter. An illustrated account of tests of the Stonebaugh Guy Anchor, and data as to the holding power. 700 w. Sib Jour of Engng—April, 1901. No. 40520 C.

The Outlook of the Cedar Pole Supply. C. H. Worcester. An illustrated account of the work of preparing these poles for market and the comparatively limited supply. 2800 w. Telephony—April, 1901. No. 40298.

Switch.

Automatic Cut-Out Switch for Heavy Currents (Selbstthätiger Starkstrom-Hebelschalter). Friedrich Natalis. An illustrated description of a switch which is cut out automatically in emergencies, and which cannot be closed again before the automatic cut-out device is set. 1000 w. Elektrotech Zeitschr—April 11, 1901. No. 40432 B.

Underground.

Notes on Some Systems of Laying Underground Cables. Arthur Devey. Abstract of paper read before the Glasgow Section of the Inst. of Elec. Engs. The discussion of armored or unarmored cables laid direct in the ground, and pipe, or conduit systems is presented in this number. 2200 w. Elec Rev, Lond—April 5, 1901. Serial. 1st part. No. 40324 A.

Wiring.

Notes on Wiring Rules. F. Broadbent. Abstract of a paper read before the Newcastle Sec. of the Inst. of Elec. Engrs. Compares the rules and requirements of various companies on specific subjects. 4300 w. Elect'n, Lond—April 12, 1901. No. 40505 A.

Some Notes on Electric Wiring. George A. Clark. Abstract of a paper read before the Glasgow Sec. of the Inst. of Elec. Engrs. Points out some of the most serious defects, and suggests a remedy where possible. 1500 w. Elect'n, Lond—April 12, 1901. No. 40506 A.

ELECTRO-CHEMISTRY.

Accumulators.

Recent Progress in Accumulator Manufacture. John H. West. Considers the defects and disadvantages from which these appliances suffer and ways of remedying them. Ill. 2500 w. Elec Chem & Met—March, 1901. Serial. 1st part. No. 40120 A.

Storage Battery Maintenance. Thomas J. Fay. Gives tests for undesirable ingredients and explains their importance. 2800 w. Elec Wld & Engr—April 6, 1901. No. 40208.

See Electrical Engineering, Generating Stations.

Alkalies.

The Outhenin-Chalandre Electrolytic Alkali Process. John B. C. Kershaw. Illustrated description of a process for the production of alkalies and chlorine compounds by the electrolysis of solutions of sodium or potassium chloride. 1000 w. Elect'n, Lond—March 29, 1901. No. 40230 A.

Bleaching.

Electrolysis in Bleaching Textiles. Detailed description of an invention for producing bleaching liquor out of ordinary brine, the product being sodium hypochlorite. Ill. 700 w. U. S. Cons Repts, No. 1004—April 6, 1901. No. 40191 D.

Mercury.

The Electrolytic Purification of Mercury. Woolsey McA. Johnson. Describes an experiment made for clearing mercury by electro-chemical means. Ill. 850 w. Elec Wld & Engr—April 20, 1901. No. 40394.

Reflectors.

An Electrolytic Process for the Manufacture of Parabolic Reflectors for Searchlights and Locomotive Headlights. Sherard Cowper-Coles. An illustrated description of the process invented by the writer. 3500 w. Elec Chem & Met—March, 1901. Serial. 1st part. No. 40119 A.

ELECTRO-PHYSICS.

Earth Currents.

The Investigation of Earth Currents (Die Erdstrom-Erforschung). Prof. Foerster. An address before the Elektrotechnischer Verein, giving an account of the research work on earth currents on German telegraph lines carried on by a committee of the above society. 3500 w. Elektrotech Zeitschr—April 11, 1901. No. 40434 B.

Electric Inertia.

On Electric Inertia and the Inertia of Electric Connection. Arthur Schuster. Mathematical investigations. 4300 w. Elect'n, Lond—April 5, 1901. No. 40320 A.

Electric Sparks.

Rotations from Electric Sparks. Alfred G. Dell. Describes interesting experiments. 3300 w. Elec Wld & Engr—March 30, 1901. No. 40138.

Gyroscopes.

Electrical Gyroscopes. Howard B. Dailey. Illustrated description of continuously-acting gyroscopes, using static electricity as a motive agent. 2000 w. Sci Am—April 20, 1901. No. 40350.

Induction.

Induction Experiments. Emile Guarini. An account of experiments made to show that it is possible to obtain in an induced circuit a current producing the same effect as a continuous current. 2900 w. Elec Engr, Lond—March 29, 1901. No. 40225 A.

Interrupter.

A New Electrolytic Interrupter (Ein Neuer Elektrolytischer Unterbrecher). John Härdén. An illustrated description of an interrupter on the Simon principle, but with a punctured porcelain insulator instead of a punctured glass plate. 800 w. Elektrotech Zeitschr—March 21, 1901. No. 40421 B.

Laboratories.

Electrical Equipment of the New Physical Laboratories, Owens College. W. P. Steinthal. An illustrated description of the electrical arrangements for lighting, power, and experimental work. 2500 w. Elec Rev, Lond—April 12, 1901. No. 40501 A.

Magnets.

A Contribution to the Theory of Permanent Magnets (Zur Theorie Permanenter Magnete). J. Busch. A discussion of the magnetomotive force, the length of the magnetic circuit and the air gap in permanent magnets. 500 w. Elektrotech Zeitschr—March 14, 1901. No. 40417 B.

X-Rays.

The Present State of X-Ray Work. William C. Peckham. Concerning the satisfactory work now possible, and the changes made in the static machine. 1200 w. Sci Am—April 20, 1901. No. 40349.

GENERATING STATIONS.

Accumulators.

The Maintenance of Central Station Batteries. A. J. Abraham. Gives instances of the abuse accumulators receive in most electricity works, and suggestions for keeping them in a healthy condition. 1300 w. Elec Rev, Lond—April 12, 1901. No. 40502 A.

Alternating vs. Continuous.

See Electrical Engineering. Distribution.

Armature Windings.

Modern Windings for Slatted Armatures (Moderne Wickelungen für Genuthete Gleichstromanker). Alexander Rothert. An illustrated description of various windings, with a discussion of the whole subject. 2400 w. Elektrotech Zeitschr—April 11, 1901. No. 40431 B.

Dynamos.

Direct-Current Generators. Sidney H. Short. Read before the Manchester Section of the Inst. of Elec. Engs. Discussion with a view to more nearly standardizing this class of electrical machinery. 4000 w. Elec Engr, Lond—March 29, 1901. No. 40226 A.

Electric Machinery.

Apparatus for Power Distribution from Central Stations. Charles F. Scott. Considers the various types of electrical machinery, particularly generators, rotary converters and motors, showing some recent types of construction, and the characteristics of their performance. Ill. 8500 w. Jour Fr Inst—April, 1901. No. 40158 D.

Generating Set.

An 825-Kilowatt Generating Set at the Paris Exposition (Exposition de 1900: Groupe Electrogène de 825 Kilowatts). Ch. Dantin. A well illustrated description of a Carels horizontal, tandem, compound engine, directly coupled to a Kolben triphase generator. 1 plate. 2200 w. Génie Civil—March 30, 1901. No. 40446 D.

A 2200-Horse-Power Generating Set at the Paris Exposition (Exposition de 1900: Groupe Electrogène de 2200 Chevaux). Georges Henry. A well illustrated description of a vertical triple-expansion steam engine, constructed by the United Augsburg-Nuremberg Machine Works, directly coupled to a 900-kilowatt continuous-current dynamo, and to an 850-kilowatt triphase generator, built by Schuckert. 1 plate. 4000 w. Génie Civil—March 16, 1901. No. 40442 D.

Hydro-Electric Station.

Construction of the Shawinigan Water and Power Company's Plant. Illustrated detailed description of an important water-power development in Canada. 3500 w. Can Engr—April, 1901. Serial. 1st part. No. 40293.

See Civil Engineering, Canals, Rivers and Harbors; and Mechanical Engineering, Hydraulics.

Indiana.

The Power Generating and Distributing System of the Union Traction Co. of Indiana. Illustrated description of the new

power house, and information concerning the lines. 9000 w. St Ry Rev—April 15, 1901. No. 40387 C.

Manchester, Eng.

Electricity Supply for Greater Manchester. Illustrated description of important extensions and three-phase transmission system. 3300 w. Elect'n, Lond—April 12, 1901. No. 40504 A.

Manhattan Elevated.

The Power Station of the Manhattan Elevated Railway. Illustrated description of the new power station on the East River, between 74th and 75th streets, New York. 4400 w. Power—April, 1901. No. 40122.

Parallel Running.

Speed Variations of Engines Direct-Connected to Alternators. A. H. Kruesi. A discussion of difficulties and means of overcoming them. The present article considers principally the calculation of crank effort, velocity and displacement. 2000 w. Elec Wld & Engr—April 13, 1901. Serial. 1st part. No. 40286.

Polyphase Generators.

The Drop of Potential in Rotary Current Generators (Spannungsabfall von Drehstromgeneratoren). F. Niethammer. A mathematical discussion, with diagrams. 800 w. Elektrotech Zeitschr—March 21, 1901. No. 40418 B.

Polyphase Machinery.

Polyphase Sub-Station Machinery. A. C. Eborall. Read before the Inst. of Elec. Engs., London. Discusses the equipment and operation of polyphase substations, with features of working and a comparison of different types of machinery, etc. 2 parts. 16500 w. Engng—March 22 and 29, 1901. No. 40108 each A.

Rotary Converters.

The Design of Rotary Converters (Ueber die Berechnung Rotirender Umformer). Hans S. Meyer. A general account, theoretical and practical, of the design of these machines, taking up each point in order, with illustrations and diagrams. 4000 w. Elektrotech Zeitschr—April 4, 1901. No. 40427 B.

Station Management.

Should Central Stations Furnish Incandescent-Lamp Renewals Free? C. A. Vallette. Read before the Illinois State Elec. Assn. Concludes that it depends altogether on local conditions and on the operating expenses. 1800 w. W Elect'n—April 6, 1901. No. 40215.

The Card System Applied to Central Electric Supply Stations. F. W. Farrer-white. An outline of the method adopted at a central station in England, showing the applicability of this system to the requirements. 900 w. Elec Rev, Lond—March 22, 1901. Serial. 1st part. No. 40-117 A.

Switchboards.

Switchboards. T. D. Boyles. Considers points in design which affect the safety and reliability. 3300 w. Engr, U S A—April 15, 1901. No. 40343.

LIGHTING.

Arc Lamps.

Arcs from Electrolytic Oxide Electrodes. Reviews an article by Mr. Ewald Rasch, appearing in the *Elektrotechnische Zeitschrift*. 1600 w. Elec Rev, N Y—March 30, 1901. No. 40098.

Remarks on an Article by Herr Rasch on a New Method of Producing Electric Light (Bemerkung zur Notiz des Herrn Rasch "Ein Neues Verfahren zur Erzeugung von Elektrischem Licht"). Prof. W. Nernst. A criticism of some of the figures for the efficiency of arc lights and Nernst lamps given by Herr Rasch, and doubts as to the commercial practicability of the Rasch electrolytic arc lamp. 800 w. Elektrotech Zeitschr—March 21, 1901. No. 40-419 B.

Mechanical Equivalent.

Mechanical Equivalent of Light. Carl Hering. A discussion of the determinations of the energy required to produce a unit quantity of light rays made by Tumlirz and by Thomsen, reducing them to more convenient terms. 3400 w. Elec Wld & Engr—April 20, 1901. No. 40393.

Mercury-Vapor Lamp.

The Cooper Hewitt Lamp. Illustrated account of the high-power electric lights exhibited at Columbia University, in which a gas is used as the illuminating medium instead of the usual filament. 1000 w. Sci Am—April 27, 1901. No. 40540

Reflectors.

See Electrical Engineering. Electro-Chemistry.

Safety Lamps.

See Mining and Metallurgy. Mining.

Searchlights.

Searchlight Signaling at the Pan-American Exposition. Orrin E. Dunlap. An account of the proposed display during the months of the exposition, showing the beautiful effects and the great usefulness of searchlights. 2000 w. Sci Am Sup—April 27, 1901. No. 40541.

MEASUREMENT.

Alternating Currents.

The Influence of the Form of the Current Curve on Measuring Instruments (Der Einfluss der Kurvenform auf Messinstrumente). Dr. Gustav Benischke. A brief account, with diagrams, showing that electromagnetic instruments are affected by the curve form, while induction instru-

ments are affected by the speed. 200 w. Elektrotech Zeitschr—April 4, 1901. No. 40428 B.

Galvanometers.

The Apparent Resistance of a Ballistic Galvanometer of the Moving Coil Type, and a Method of Allowing for the Damping Current. David Robertson. An account of experiments, describing methods and results obtained. 2000 w. Elect'n. Lond—April 5, 1901. Serial. 1st part. No. 40321 A.

Resistance Boxes.

A New Kind of Resistance Box with Rotating Contact Pieces (Eine Neue Art von Kurbelrheostaten für Messzwecke). Dr. Rudolf Franke. An illustrated description of a rheostat in which the resistance coils are cut in and out by a rotating sliding contact, instead of by plugs. 500 w. Elektrotech Zeitschr—March 28, 1901. No. 40425 B.

Precision Rheostat and Bridges with Rotating Contact Pieces (Präcisions-Kurbelrheostaten und-Brücken). Prof. M. Th. Edelmann. A short illustrated description of a Wheatstone bridge in which the resistances are cut in and out by rotating contacts, instead of by plugs. 300 w. Electrotech Zeitschr—March 21, 1901. No. 40420 B.

Stray Currents.

Earth Potential Curves from Chicago, Toledo and Columbus. Interesting curves representing the contour lines of electric pressure in the earth under the influence of the electric railway system of current distribution. 600 w. Elec Wld & Engr—April 13, 1901. No. 40287.

The Measurement of Electric Currents in Underground Pipes (Ueber Messungen der Elektrischen Ströme in den Städtischen Rohrleitungen). Sigvald Krohn. An article giving the method and results of measurements of stray currents from electric tramways in gas and water pipes, with recommendations for the avoidance of this trouble. Diagrams. 2000 w. Elektrotech Zeitschr—March 28, 1901. No. 40423 B.

POWER APPLICATIONS.

Coal Mines.

Some Notes on the Electrical Transmission of Power in Coal Mines. H. Ravenshaw. Read before the Brit. Inst. of Elec. Engrs. Discusses the special features met with in electric power plants in coal mines and gives a record of difficulties and mishaps which have come directly under the notice of the author. 3000 w. Elec Rev, Lond—April 12, 1901. No. 40503 A.

The Electrical Transmission of Power in Coal Mines. H. Ravenshaw. Read before the Inst. of Elec. Engrs., England. A discussion of the special features, and a record of difficulties and mishaps. 9000 w. Ir & Coal Trds Rev—March 29, 1901. No. 40246 A.

Comparison.

A Comparison Between Electrical and Mechanical Transmission. H. H. Holding. From a paper read before the Asso. Tech. Club of Cleveland, Ohio. Gives results showing that there is no reason why a factory cannot be driven more cheaply and advantageously by electricity than by direct mechanical means. 1600 w. Am Mach—April 25, 1901. No. 40538.

Cranes.

New Electric Cranes (Neuere Elektrisch Betriebene Hebegeuge). An illustrated account of movable cranes for shops and wharves, built by the Benrath Machine Co., and driven by polyphase motors. 1500 w. Zeitschr d Ver Deutscher Ing—March 30, 1901. No. 40403 D.

150-Ton Electric Crane at Bremerhaven Harbor (Elektrischer 150t-Krahn im Bremerhavener Hafen). An illustrated article from *Uhlands Verkehrszeitung*, giving a description of this large cantilever crane for use on the wharves. 800 w. Oesterr Wochenschrift f d Oeffent Baudienst—March 30, 1901. No. 40438 D.

Fan Motor.

The Construction of a Direct-Current Fan Motor. Illustrates and describes a compact form of fan motor easily constructed by one familiar with the use of machine tools. 1400 w. Am Elect'n—April, 1901. No. 40162.

Irrigation Pumping.

See Civil Engineering, Canals, Rivers and Harbors.

Mining Plant.

The Electric Power Station at the Pierrefitte Mines. E. Henry Davies. From a paper read before the Inst. of Min. & Met. Brief description of power plant for these lead and blend mines in the French Pyrenees. 700 w. Col Guard—March 29, 1901. No. 40264 A.

Motors.

Electric Motors: A Brief Outline of Their Characteristics. A. Saunders Morris. Suggestions as to the type of motor which should be selected for required work, and urging that more definite information be furnished to designers of electrical apparatus. 2800 w. Stevens Ind—April, 1901. No. 40367 D.

Packing House.

Alternating Current Power Equipment in a Packing House. Illustrated descriptions of the centralized power plants of Swift & Company, at Chicago, Ill., and St. Joseph, Mo. 1800 w. Am Elect'n—April, 1901. No. 40161.

Polyphase Motors.

The Distribution of Lines of Force in Rotary Current Motors (Zur Kraftlinienvertheilung in Drehstrommotoren). J. B. Krantz. A mathematical discussion, with diagram and table. 700 w. Elektrotech Zeitschr—March 28, 1901. No. 40424 B.

Power Plant.

Electrical Plant of the Curtis Publishing Company, Philadelphia, Pa. John S. Griggs, Jr. Illustrated detailed description of a plant for furnishing light, heat and power to two buildings. 3500 w. Elec Rev, N. Y.—April 6, 1901. No. 40204.

Power Plant of the Edward Ford Plate Glass Co. T. L. Farnham. Illustrated description of a plant near Toledo, Ohio which is probably the largest manufacturing plant entirely equipped with electrically driven machinery. 6000 w. Engr U. S. A.—April 1, 1901. No. 40205.

The Generation and Distribution of Power in the Olympia Mills. Illustrated description of a 5,000 H. P. plant and electric distribution system in a cotton mill at Columbia, S. C. The electric plant was cheaper in first cost, and is expected to be cheaper in operation and maintenance, than a shafting system. 3000 w. Eng Rec—April 6, 1901. No. 40174.

Pump.

See Mechanical Engineering, Hydraulics.

Switching Out.

The Switching Out of Shunt-Wound Electric Motors Without Sparking (Bedingungen des Funkenfreien Ausschaltens für Nebenschlussmotoren). Rudolf Krause. A description, with diagrams, of methods of avoiding sparking at the starting switch of continuous current motors. 800 w. Elektrotech Zeitschr—March 14, 1901. No. 40416 B.

TRANSMISSION.

Mexico City.

Power Transmission at Mexico City. C. R. Mundinger. Brief account of the water-power plants for power transmission to this city. 1400 w. Elec Wld & Engr—April 20, 1901. No. 40395.

Niagara.

Recent Developments at the Niagara Falls Power Plant. Arthur B. Weeks. Illustrations and brief description of the aluminium transmission line by means of which electric current will be sent to the Pan-American Exposition; the changes in the lightning arrester apparatus, etc. 1000 w. Sci Am—April 13, 1901. No. 40257.

Utah.

Power Transmission in Utah. J. R. Cravath. Results and lessons from the operation of the long-distance power transmission and distribution systems of the Utah Light & Power Company. Ill. 5800 w. Elec Wld & Engr—March 30, 1901. No. 40137.

MISCELLANY.

Benjamin Franklin.

Benjamin Franklin's Contributions to Electrical Science. Edwin F. Northrup. Begins a review, in some detail, of his contributions to electrical knowledge. The present article deals with his experiments on the action of points on the electric charge. 2700 w. Elec Rev, N. Y.—March 30, 1901. Serial. 1st part. No. 40007.

Carbon.

The Manufacture and Testing of Carbon for Electrical Purposes (Herstellung und Prüfung von Kohle für Elektrotechnische Zwecke). J. Härdén. A well illustrated account of the preparation and testing of carbons for electrodes, brushes, arc lights and other purposes. 4500 w. Elektrotech Zeitschr—April 11, 1901. No. 40433 B.

Glasgow Exhibition.

See Mechanical Engineering, Miscellany.

Graphite.

The Artificial Production of Graphite. Clinton Paul Townsend. An account of some of the modifications undergone by carbon, and the conditions governing them, with inferences drawn. 5800 w. Elec Wld & Engr—April 6, 1901. No. 40207.

India.

The Use of Electricity in India. George Cecil. An illustrated article telling of the development of electricity in the country. 1600 w. Elec Engr, Lond—April 5, 1901. No. 40318 A.

Lightning Protection.

The Protection of Buildings from Lightning (Ueber Gebäude-Blitzableiter). K. Strecker. The report of a committee of the Elektrotechnischer Verein, with the proposed rules for the protection of buildings against lightning. Also editorial comment. 1800 w. Elektrotech Zeitschr—April 11, 1901. No. 40430 B.

GAS ENGINEERING

Blast-Furnace Gas.

Progress in the Utilisation of Blast-Furnace Gases (Weitere Fortschritte in der Verwendung der Hochofengase zur Unmittelbaren Krafterzeugung). Fritz W. Lürmann. Abstract of a paper before the Verein Deutscher Eisenhüttenleute giving an account of the recent extensive use of blast-furnace gases in gas engines in various countries. 2000 w. Zeitschr d Ver Deutscher Ing—April 13, 1901. No. 40410 D.

Coal Gas.

Coal Gas and Its Various Competitors. Franz Schaeffer. Report presented to the International Gas Congress in Paris. A review of the production and consumption of coal gas, electricity, acetylene, water, gas, etc. 3900 w. Jour Gas Lgt—April 9, 1901. No. 40345 A.

Coke Ovens.

By-Product Coke Ovens or Improved Coal Gas Works for a City Supply—A Comparison. Frederic Egner. A discussion of this subject, especially presenting the other side of the coke oven or gas works question. 1900 w. Am Gas Lgt Jour—April 22, 1901. No. 40391.

Electrolysis.

The Effect of Stray Trolley Currents. H. E. McGowan. Gives results and conclusions from experience in connection with the Brooklyn Union Gas Co. Ill. 1700 w. Stevens Ind—April, 1901. No. 40369 D

The Question of Electrolysis. Abstract translation from the *Journal für Gasbeleuchtung*. Continental, American and English experience, the remedy, etc. 3500 w. Gas Wld—March 30, 1901. No. 40229 A.

Gas Engines.

See Mechanical Engineering, Gas and Oil Engines.

Incandescence.

A Combination to Test the Welsbach Patent of '93. An account of competition in England and the steps being taken to test the validity of the Welsbach 1893 patent. 1800 w. Jour Gas Lgt—April 16, 1901. No. 40558 A.

A New Method of Incandescent Gas Lighting. G. Mollberg. Read at meeting of the German Gas Assn. A description of the Selas apparatus. 1200 w. Gas Wld—April 13, 1901. No. 40399 A.

Improvement in Welsbach Gaslights. An account of improvements discovered and perfected by Rudolph Langhans, an Austrian engineer, which makes the mantle stronger and maintains the constancy of the light emission, and also corrects other defects, thus making it applicable under conditions where hitherto no mantle could be used. 1300 w. U. S. Cons Repts. No. 1007—April 10, 1901. No. 40248 D.

Relation of Heating to Lighting Power of Gas with Special Reference to Incandescent Mantles. Herman Russell and Alfred H. White. Read at meeting of the Michigan Gas Assn. An account of experimental investigations. 3800 w. Am Gas Lgt Jour—April 1, 1901. No. 40153.

The Change Occurring in the Illuminative Value of Mantles with Lapse of Time. Dr. Emil Liebenthal. An account of investigations made to determine the duty afforded by the different varieties. 1300 w. Jour Gas Lgt—April 16, 1901. No. 40560 A.

The Incandescent System of Gas Lighting. On the great value of the Welsbach burner to the gas industry, and to the public, with a discussion of some of its defects. 5600 w. Engr, Lond—April 12, 1901. No. 40515 A.

India.

Gas: Its Uses in India. George Cecil. An account of conditions and the degree of progress in the use of gas, showing the country to be very slow in adopting modern improvements. 2000 w. Jour Gas Lgt—March 12, 1901. No. 40315 A.

Mond Gas.

South Staffordshire Mond Gas Scheme. Describes the South Staffordshire coal fields, whose peculiarity is the great thickness of the seams and the numerous faults, and the present conditions, and explains a scheme for the use of Mond gas as a means of economical pumping. 2400 w. Eng, Lond—March 22, 1901. Serial. 1st part. No. 40111 A.

Mulhouse.

The New Gas-Works at Mulhouse. Illustrated particulars of these new gas-works in a town in Germany. 2300 w. Jour Gas Lgt—April 16, 1901. No. 40561 A.

Power Gas.

Power Gas in France: The Pierson System. Reviews briefly the attempts made by French engineers to produce fuel gas from the poor native coal, and gives information concerning the successful process named. 2300 w. Jour Gas Lgt—April 16, 1901. No. 40559 A.

Vienna.

The Central Gas-Works of Vienna. Herr Th. Herrmann. Illustrated description of works of exceptional interest, planned on an extensive scale and finely equipped. 8000 w. Jour Gas Lgt—March 26 and April 2, 1901. Serial. 2 parts. No. 40172 each A.

MARINE AND NAVAL ENGINEERING

Balancing Engines.

On the Balancing of the Reciprocating Parts of Engines, Including the Effect of the Connecting-Rod. W. E. Dalby. Read before the Brit. Inst. of Naval Archts. The paper is wholly concerned with balancing reciprocating masses amongst themselves, taking into account the variation of the simple harmonic motion caused by the connecting-rods. Ill. and Dis. 5500 w. Engng—April 5, 1901. Serial. 1st part. No. 40329 A.

Boilers.

Experiments on a Niclausse Water-Tube Boiler. Summarized by Bryan Donkin, from a paper read at the Paris Congress. Describes the results of tests giving the evaporation from each row of tubes in a Niclausse generator, and at different rates of combustion, with heat efficiencies. 1400 w. Engr, Lond—April 5, 1901. No. 40331 A.

On a Form of Double Tube Boiler. John Irving. Read before the Brit. Inst. of Naval Archts. Illustrated description of the construction and performance of a boiler designed for the mercantile marine. 2000 w. Engr, Lond—April 5, 1901. No. 40334 A.

Water-Tube Boilers. Edwin Griffith. Read before the North-East Coast Inst. of Engs and Shipbuilders. Considers the present position of water-tube boilers from the point of view of the marine engineer. 6200 w. Engs' Gaz—April, 1901. No. 40223 A.

Water-Tube Boilers in the British Navy. A statement of the events which led to the appointment of an expert commission, and a copy of the report submitted. 2500 w. Eng News—April 4, 1901. No. 40149.

Boston Ships.

Boston Ships: Past and Present. R. G. F. Candage. Concerning the ships built in, owned and sailed into and out of the port of Boston from its settlement to the present time. 5500 w. Naut Gaz—April 4, 1901. No. 40201.

Celtic.

Celtic. Largest Vessel Ever Built. Brief description of a large vessel launched recently, designed to carry an immense cargo, but with ample accommodations for passengers. 1200 w. Marine Rev—April 11, 1901. No. 40309.

The White Star Liner "Celtic." Illustrates and describes the structural features, which are particularly interesting because of the size of the vessel and the great strength of her scantlings. 2700 w. Engng—April 12, 1901. No. 40512 A.

Channel Service.

The Cross-Channel Passenger Steamship Services. Historical review of the channel-service from the earliest use of steamships. Ill. 2200 w. Engr, Lond—March 29, 1901. Serial. 1st part. No. 40244 A.

Cylinders.

On a New Assistant Cylinder. David Joy. Read before the Brit. Inst. of Naval Archts. On recent improvements and advances in construction and efficiency. 1700 w. Engng—April 5, 1901. No. 40328 A.

Dry-Dock.

See Civil Engineering, Canals, Rivers and Harbors.

Fast Scout.

A Design for a Fast Scout. C. C. P. Fitzgerald. Read before the Brit. Inst. of Naval Archts. Describes a design for a scout of high speed and good sea-going qualities, and gives reasons for proposing such a vessel. 1400 w. Engng—March 29, 1901. No. 40239 A.

Great Lakes.

A Chicago and European Steamship Line. An account of a line of freight carriers; the first vessel having sailed from Chicago on April 24. 800 w. Ir Age—April 20, 1901. No. 40535.

Magnificent Lake Steamboats. Illustration and description of two large passenger vessels for service on Lake Erie. 1100 w. Naut Gaz—April 11, 1901. No. 40271.

New Lake Superior Passenger Boat. Illustration with brief description of the new steel passenger and freight propeller "Argo." 600 w. Naut Gaz—April 18, 1901. No. 40389.

Old-Time Lake Steamboats. Illustrated account of two famous vessels that plied on Lake Erie before the Civil War. 1500 w. Naut Gaz—April 11, 1901. No. 40272.

Guns.

Seven-Inch vs. Six-Inch Guns for Our New Armored Cruisers. Paul D. Emmons. A reply to objections made to the proposed change. 1700 w. Sci Am Sup—April 20, 1901. No. 40353.

Japan.

Trade and Shipbuilding at Nagasaki. Notes on the present position of a port rapidly becoming one of the most important in the Far East. 2300 w. Engng—March 22, 1901. No. 40106 A.

Korea.

Launch of the Pacific Mail Liner "Korea." Brief illustrated description of the largest steamship ever built in Amer-

ica, which is to ply between San Francisco and Hong Kong, carrying freight and passengers. 700 w. Sci Am—April 13, 1901. No. 40256.

Kronprinz Wilhelm.

New North German Lloyd Atlantic Steamer "Kronprinz Wilhelm." Describes this vessel recently launched, making another high-speed steamer of great size for this company. 900 w. Engng—April 12, 1901. No. 40514 A.

Naval Stations.

French Naval Stations. Discusses the proposed improvements providing for the accommodation of the vessels of the new navy and creating naval stations for the defence of the colonies. 2400 w. Engr, Lond—March 29, 1901. No. 40243 A.

Ore Carriers.

The New Ore Carrying Fleet of 1901. Waldon Fawcett. Discusses the changed conditions and the effect on the fleet of vessels for the Great Lakes. 300 w. Ir Age—April 25, 1901. No. 40534.

River Steamer.

Clyde River Passenger Steamer. George C. Cook. Illustrated description of a special type of speedy vessel developed to meet local conditions. 1800 w. Marine Rev—March 28, 1901. No. 40091.

Rolling.

An Instrument for Measuring the Rolling of Ships. A. Mallock. Read before the Brit. Inst. of Naval Archts. Illustrated description of a rolling indicator, which is said to give very accurate measure of the rolls in all circumstances. 3400 w. Engng—March 29, 1901. No. 40237 A.

Shipbuilding.

Shipbuilding in Germany, and the Imperial German Navy. Information compiled from various sources. 1800 w. Jour U. S. Art—March-April, 1901. No. 40130 D.

The Mechanical Equipment of the Ship-Yard. Prof. J. H. Biles. A clear explanatory discussion of the processes of shipbuilding, devoted particularly to the framing of the vessel and the punching and shearing machines used in the work. Ill. Serial. 1st part. 3000 w. The Engineering Magazine—May, 1901. No. 40452 B.

Ship Propulsion.

Taylor's Analysis Applied to a Screw Ferryboat. Col. E. A. Stevens and Charles P. Paulding. Gives the results of work on the trials of the "Cincinnati." 2800 w. Stevens Ind—April, 1901. No. 40368 D.

Ship-Railway.

The Anderson Ship-Railway. Brief illustrated description of a proposed railway invented by Axel B. Anderson of Brooklyn, N. Y., an improvement on the construction proposed by Captain James Eads, in 1883. 800 w. Sci Am Sup—April 13, 1901. No. 40261.

Ship Resistance.

Pressure in Submerged Moving Plates. C. Humphrey Wingfield. Read before the Brit. Inst. of Naval Archts. Instead of considering actual propellers, the more simple case of a plane is taken for the study of the influence of depth of immersion in the distribution of pressure. Ill. 1500 w. Engng—March 29, 1901. No. 40238 A.

Shipyards.

Messrs. Yarrow and Co.'s New Works. Illustrated description of the new works at Poplar. 1100 w. Engng—April 5, 1901. No. 40327 A.

Some Remarks on the Commercial Organization of Shipyards. Walter Scott. Considers the correspondence, estimating, buying, cost, keeping, book-keeping, commercial staff, etc. 4500 w. Naut Gaz—April 18, 1901. No. 40390.

Speed Power Trials.

Speed and Power Trials of Ships. W. F. Durand. A brief discussion of a simple speed or speed power trial, without involving the detailed anaylsis of the general propulsion performance. 2000 w. Sib Jour of Engng—April 1, 1901. No. 40521 C.

Steam Lighter.

Stanch Steam Lighter. Description with illustration, of the "Rocket" being built for the U. S. government. 700 w. Naut Gaz—April 4, 1901. No. 40200.

Steam Turbine.

The Marine Steam Turbine and Its Application to Fast Vessels. C. A. Parsons. Briefly reviews the history of the steam turbine and its application to the propulsion of ships. General discussion. Ill. 8500 w. Trans Inst of Engr & Shipbuilders in Scotland—March, 1901. No. 40555 E.

Steam Yacht.

The Twin-Screw Steam Yacht "Prinzessin Victoria Luise" (Die Doppelschrauben-Dampfyacht "Prinzessin Victoria Luise"). A very complete and well-illustrated description of this fine new vessel of the Hamburg-American line, and of her engines and boilers. 4 plates. 4000 w. Zeitschr d Ver Deutscher Ing—April 6, 1901. No. 40405 D.

Submarine.

Construction and Tests of Submarine Torpedo Boats for the U. S. Navy. Plan showing the chief characteristics of the boats being constructed by the U. S. Navy, with extract from Admiral Hichborn's report, and description of the "Holland" are given in the present article. 2500 w. Marine Engng—April, 1901. Serial. 1st part. No. 40212 C.

Submarine Boats for the British Navy. Sectional drawing of the improved Holland submarine boat, of which five are being built for the British Navy, with comment and description. 2500 w. Engng—March 29, 1901. No. 40236 A.

The Motion of Submarine Boats in the Vertical Plane. William Horgaard. Read before the Brit. Inst. of Naval Archts. An examination of the qualities of stability of motion and manœuvring power, and the manner in which they are affected by varying the rudders, the amount and distribution of buoyancy, shape of hull, etc. 3500 w. Engng—April 5, 1901. Serial. 1st part. No. 40330 A.

The Submarine Boat: Its Promises and Performances. George W. Melville. Reviews the history of submarine boat construction and discusses the merits of such craft. 6000 w. N Am Rev—April, 1901. No. 40121 D.

Topophone.

The Topophone. Illustrates and describes a device for determining the direction of a fog signal at sea, and to enable the sounds to be heard at greater distance. 1100 w. Sci Am—March 30, 1901. No. 40099.

Towboats.

Towing and Towboats. Theodore Lucas. Illustrated description of modern tow-boats and arrangements for towing transportation. 1800 w. Naut Gaz—April 4, 1901. No. 40202.

Vibration.

The Vibration of Steamers. Otto Schlick. Read before the Brit. Inst. of Naval Archts. On some experiments made on board the Atlantic liner "Deutschland," during her trial trip in June, 1900. 6300 w. Engng—March 29, 1901. No. 40242 A.

Wreck.

Loss of the Pacific Mail Steamship City of Rio de Janeiro. A report of the Federal investigation as to the responsibility for this accident which occurred Feb. 22, in San Francisco bay, resulting in the loss of 131 lives and millions in property. 3000 w. Marine Engng—April, 1901. No. 40210 C.

Yachts.

Fifteen Years' Development of the 90-Foot Racing Yacht. A comparison as shown by the "Galatea," the cutter of 1886, and the "Independence," the cutter-sloop of 1901. Ill. 2000 w. Sci Am—April 13, 1901. No. 40259.

The International Racing Yacht "Independence." Particulars, with illustrations, of this cup-defender now under construction. 2000 w. Sci Am—March 30, 1901. No. 40100.

MECHANICAL ENGINEERING

AUTOMOBILISM.

American Vehicles.

The Automobile in America. Brief illustrated descriptions of several heavy vehicles. 2500 w. Auto Jour—April, 1901. No. 40548 A.

The Automobile Industry in the United States. A symposium describing its present condition, with descriptions and illustrations of various types of vehicles, and a brief review of the industry abroad. 11000 w. Elec Rev, N. Y.—April 13, 1901. No. 40284.

Artillery.

A Motor Field Battery. H. A. Bethell. Discusses the advantages and objections to the steam car for military purposes. 4000 w. Auto Jour—April, 1901. No. 40553 A.

Carburettors.

Carburettors. The term as used includes all forms of apparatus for enabling engines to be run with the heavier oils which are not volatile at ordinary atmospheric pressure. Considers their characteristics and peculiarities as compared and contrasted with one another. Also illustrated description of types. 4400 w. Auto Jour—April, 1901. No. 40552 A.

Dawson.

The Dawson Car. Illustrated description. 1000 w. Autocar—April 6, 1901. No. 40314 A.

Economy.

The Prospects for Economical Automobiling. M. C. Krarup. Discusses the outlook, the difficulties involved, etc. 3500 w. Ir Age—April 25, 1901. No. 40533.

Electric Motors.

Selection of Electric Motors. C. E. F. Ahlm. Treats of points in motor design which may be the cause of unusual drain on the battery of an electric vehicle. 1600 w. Horseless Age—April 17, 1901. No. 40342.

Endurance Test.

The Long Island Automobile Club's One Hundred Mile Endurance Test. An account of the run made in very bad weather, with illustrations. 3000 w. Horseless Age—April 24, 1901. No. 40556.

Ignition.

Sparking Troubles. C. H. Guest. From a paper read before the Nottingham (England) Automobile Club. Instruction for users of spark igniters, referring more

particularly to jump spark ignition. 4800 w. Horseless Age—April 10, 1901. No. 40267.

The Elements of Electric Ignition for Automotors. General information for those in need of the knowledge, dealing especially with the jump spark system. 3500 w. Auto Jour—April, 1901. No. 40546 A.

Paris Exposition.

The Competition of Automobiles for Industrial Purposes (Compte Rendu des Concours d'Automobilisme Industriel). M. G. Forestier. A report on the trials of automobiles for cab and omnibus service, trucks and other heavy-weight vehicles, etc., held in connection with the Paris Exposition. Tables and diagrams. 10000 w. Mem d l Soc d Ing Civils—February, 1901. No. 40474 G.

The Competitions of Moto-Cycles, Voiturettes and Touring Automobiles (Compte Rendu des Concours de Motocycles, Voiturettes et Voitures de Tourisme). M. G. Forestier. A report on the trials of the above-named classes of vehicles, held in connection with the Paris Exposition. Tables. 7000 w. Mem d l Soc d Ing Civils—February, 1901. No. 40473 G.

Racing Machines.

Racing Automobiles at the Close of 1900 (La Voiture Automobile de Course à la Fin de 1900). Count G. de Chasseloup-Laubat and M. G. Forestier. A general review of racing automobiles, with accounts of some long-distance races. 6000 w. Mem d l Soc d Ing Civils—February, 1901. No. 40472 G.

Steam Car.

A 12 H. P. Steam Car. A lettered linear elevation and plan of a passenger car in which locomotive practice is followed to the extent of arranging for direct drive upon the cranked driving wheel axle. 1000 w. Auto Car—April 20, 1901. No. 40590 A.

Traction Engines.

The Use of Traction Engines and Armored Trains in the Field. (Emploie des Locomotives Routières et des Trains Blindés en Campagne). G. Espitallier. A discussion of traction engines hauling armored trains across country, with special reference to the experiences of the British army in South Africa. Illustrated. 3000 w. Génie Civil—April 13, 1901. No. 40460 D.

Truck.

The Steam Motor Truck as a Portable Power House. J. G. Dudley. An analysis of the conditions of American service, and of the essential features of the type best adapted to them, with concise statement of conclusions. 4000 w. The Engineering Magazine—May, 1901. No. 40458 B.

War Car.

See Railways and Tramways, Motive Power and Equipment.

Wheel Diameter.

On the Influence of the Diameter of the Wheels on the Power Required for Propelling Automotors. W. A. T. Müller. An attempt to solve the question theoretically. Ill. 2000 w. Auto Jour—April, 1901. Serial. First part. No. 40551 A.

HYDRAULICS.

Pipe Joints.

Pipe Joints for High Pressures. U. Peters. Brief illustrated description of joints adapted for pressures up to 7000 pounds per square inch. 350 w. Am Mach—April 18, 1901. No. 40347.

Pump.

The Schleifmühle Electric Express Pump. J. Divis, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Illustrates and describes a pump designed for use with an electromotor, but which can also be driven by high-speed steam engines. 1000 w. Col Guard—April 12, 1901. No. 40507 A.

Pumping Engines.

Pumping Machinery at Boston and Andover, Mass. (Amerikanische Maschinen und Maschinenanlagen). C. Regenbogen. An illustrated description of the pumping machinery of the Boston Sewerage Works and of the Andover Water Works. 1800 w. Zeitschr d Ver Deutscher Ing—April 13, 1901. No. 40408 D.

Turbine Plant.

Rodney Hunt Turbine Plant at the Great Northern Paper Company's Mill. Illustrated description of this hydraulic plant at Millinocket, Maine, which is the largest of its kind in the world. 1500 w. Sci Am—April 13, 1901. No. 40258.

Turbines.

Turbine Building and Turbo-Electric Stations in Switzerland. Prof. F. Pràsil. A résumé of progress, with particular attention to the installations built since 1888 and the facilities of the largest makers at the present time, and discussion of some of the more important hydro-electric stations. Ill. 3200 w. The Engineering Magazine—May, 1901. Serial, Part I. No. 40457 B.

Water Meter.

See Mechanical Engineering, Steam Engineering.

MACHINE WORKS AND FOUNDRIES.

Boring.

Boring Elliptical Cylinders. Albert E. Guy. Describes a successful method for short cylinders. Ill. 1100 w. Am Mach—April 18. 1901. No. 40348.

Cement Machinery.

Test of Machinery in a Cement Works. Describes tests of the power required to drive kilns, conveyors, crushers, and other machinery in the Krause Cement Works. 1600 w. Eng Rec—April 20, 1901. No. 40356.

Cutting Machine.

A New Elliptical Cutting Machine. C. W. MacCord. Illustrated description of the construction and mode of operation of a machine for cutting elliptical openings. 1400 w. Sci Am Sup—April 6, 1901. No. 40220.

Drilling.

Converting an Old Planer into an Indexing Gang Driller. W. G. Luper. Illustrated description of a machine used for drilling and tapping condenser heads in a western navy yard. 900 w. Am Mach—April 11, 1901. No. 40251.

Foundry Economy.

Foundry Economy. Percy Longmuir. Briefly considers the requirements of economical castings, economical organization, and economical management. 2600 w. Ir Trd Rev—March 28, 1901. No. 40089.

Foundry Metallurgy.

Foundry Metallurgy. Herbert E. Field. A consideration of the conditions necessary to its success. 3000 w. Mach, N. Y.—April. 1901. No. 40126.

Lathes.

Tool Practice with the Conradson Heavy Turret Lathe. Gives illustrations and descriptions of some of the characteristic tools used on the lathe described in last week's issue. 1300 w. Am Mach—April 25, 1901. No. 40537.

Turret Lathe for Extra Heavy Work. Illustrated detailed description of the latest development in these machines. 1600 w. Am Mach—April 18, 1901. No. 40346.

Machine Tools.

Experiments on the Work of Machine Tools. (Experiences sur le Travail des Machines-Outils). M. Codron. A second part, dealing with cutting tools, of this article on the power consumed by machine tools. Many diagrams and figures. 5000 w. Bull Soc d' Encour—March, 1901. No. 40466 G.

The Mechanical Engineering of Machine Tools. Prof. Charles L. Griffin. A review of the essential principles and very exacting requirements of this branch of mechanical designing, with a concise statement of the requirements of the best practice. 3600 w. The Engineering Magazine—May, 1901. No. 40454 B.

Milling Chuck.

A Special Milling Chuck, and the Making of It. Mike Romitur. Illustrated description. 1600 w. Am Mach—April 4, 1901. No. 40171.

Mixing Iron.

Mixing Iron by Analysis. W. G. Scott. Gives a mixing card showing the number of pounds of coke, flux, scrap and pig iron in each charge, and describes the method of calculating the cupola mixture. 2700 w. Foundry—April, 1901. No. 40135.

Nuts.

Casting Threads in Nuts. Walter Ferris. Illustrates and describes the work, giving results. 1200 w. Am Mach—April 4, 1901. No. 40169.

Screw Machine.

A Magazine Feed for the Automatic Screw Machine. Mike Romitur. Illustrated description of a tool found valuable in the screw-machine department. 800 w. Am Mach—April 11, 1901. No. 40254.

Seamless Pipe.

The Bartlett-Kent Process for Rolling Seamless Pipe. An illustrated detailed description. 2000 w. Ir Age—April 25, 1901. No. 40532.

Shop Management.

Need of Closer Union of Financial and Practical Shop Management. Thomas D. West. A letter briefly stating the writer's opinion of the requirements to fit a young man for the position of manager, superintendent or foreman of a foundry. 2000 w. Ir Trd Rev—March 28, 1901. No. 40090.

Shops.

Machine Shop Practice. D. B. Dixon. Discusses tools and their use, methods of work, etc. 1800 w. Am Mfr—April 11, 1901. No. 40311.

Something About the Warner and Swasey Shops and Work. Illustrated description of shops in Cleveland, for the manufacture of high-grade machine tools, astronomical instruments, etc. 2800 w. Am Mach—April 4, 1901. No. 40168.

The Brown & Sharpe Mfg. Co.'s Works. An illustrated description of the buildings and views of several departments. 3000 w. Mach, N. Y.—April, 1901. No. 40125.

The Works of the Eddy Electric Manufacturing Company. Illustrated description of works for making direct-current apparatus and the methods of manufacture. 1500 w. Elec Rev, N. Y.—April 13, 1901. No. 40283.

Steel Pipe.

A New Method of Manufacturing Steel Pipe. Illustrates and describes the manufacturing methods used in making the pipe for the long pipe line to carry water to Coolgardie, Australia, the important gold mining district. 1400 w. Sci Am—March 30, 1901. No. 40101.

Tools.

A Discussion of Various Boring, Ream-

ing and Facing Tools. James Vose. Illustrates and describes tools and methods. 1200 w. Am Mach—April 4, 1901. No. 40170.

Tool Steel.

See Mining and Metallurgy, Iron and Steel.

MATERIALS OF CONSTRUCTION.

Bronze.

The Strength and Ductility of Bronze in Relation to Temperature. C. Bach, in *Zeitschrift d Ver Deutscher Ing.* A report of experiments giving tables and diagrams. 2800 w. Engr, Lond—April 5, 1901. No. 40332 A.

Steel Axles.

Specifications for Steel Axles Proposed by American Section of International Association for Testing Materials. Comments and discussion by M. H. Wickhorst, engineer of test, C. B. & Q. R. R., Aurora Ill., with communications and general discussion. 7800 w. Pro W Ry Club—March, 1901. No. 40270 C.

POWER AND TRANSMISSION.

Ball Bearings.

Steel Ball Bearings. An illustrated account of the investigations of Prof. Stribeck, on behalf of the German Arms and Ammunition Works of Berlin. An important contribution to the solution of difficult mechanical problems. 4000 w. Engng—April 12, 1901. No. 40510 A.

Cableway.

Shipping Coal by the Aerial Wire Rope System at Port Morien, Cape Breton. Joseph G. S. Hudson. Describes the system installed and its very satisfactory working. 1800 w. Can Min Rev—March 31, 1901. No. 40164 B.

Chains.

Chains and Chain Gearing. Charles Piez. Concerning the use and treatment of chains, with illustrated description of the principle of chain gearing with the ordinary types of chain, design, &c. 3500 w. Pro Engrs' Club of Phila—April, 1901. No. 40528 D.

Compressed Air.

The Location of the Compressed Air Receiver. Frank Richards. At a meeting of the N. Y. R. R. Club it was suggested that the receiver be placed in the warmest place convenient; the writer gives reasons for thinking the reverse would be the best advice. 1000 w. Am Mach—April 25, 1901. No. 40536.

Gearing.

Grisson Gearing. Presents the advantages of a gearing intended for use in cases when the present construction does not answer the requirements, especially in the management of high ratios of transmission. 2000 w. Sci Am Sup—April 20, 1901. No. 40352.

Mechanical Handling.

An Economical Method of Handling Dirt and Ballast. Spencer Miller. Plan views of two rapid unloaders, with comparison of important dimensions showing the difference in the strength of the various parts. 1000 w. R R Gaz—April 19, 1901. No. 40380.

Steam Shovel.

The Thew Steam Shovel; Cleveland, Lorain and Wheeling Ry. Illustrated description of the machine. The chief novelty is in the construction of the swinging boom and the method of manipulating the dipper. 900 w. Eng News—April 11, 1901. No. 40276.

GAS AND OIL ENGINES.

Blast Furnace Gas.

See Gas Engineering.

Diesel Motor.

The Diesel Engine in England. Illustrated description of the English made engine recently exhibited and its operation. Drawings have been prepared for Diesel motors of special design to be used on automobiles of the heavier type. 2200 w. Auto Jour—April, 1901. No. 40547 A.

The Diesel Oil-Engine. An illustrated description of the first Diesel engine made in England, which has several improvements over types made abroad. 2300 w. Elec Engr, Lond—March 29, 1901. No. 40224 A.

The Diesel Oil Engine. Illustrates a British built engine, explaining the mechanical details, and method of working 1800 w. Engng—March 29, 1901. No. 40240 A.

The Diesel Oil Engine. Remarks on the engine recently exhibited at Messrs. Scott & Hodgson's works, England. Ill. 1400 w. Elec Rev, Lond—April 5, 1901. No. 40322 A.

Gas Engines.

Large Gas Engine Practice at Cockerill's Works, Seraing. E. Kilburn Scott. Information concerning large gas engine practice, and observations during a recent visit at these works. 1500 w. Elec Rev, Lond—March 29, 1901. No. 40227 A.

Operating Gas and Gasoline Engines. Harry J. Perkins. The first of a series of articles giving information and advice of service to sellers, buyers and users. 1100 w. Am Mach—March 28, 1901. Serial. First part. No. 40088.

Power Calculations for Gas Engines. Herbert L. Towle. Discusses engine design and the development and use of formulas. 2900 w. Am Mach—April 11, 1901. No. 40253.

The Letombe Gas Engine. An illustrated description of the interesting features of

an engine designed to give economy in working and efficiency on the lower loads. Also editorial on its possibilities. 3400 w. Auto Jour—April, 1901. No. 40549 A.

Oil Engines.

Oil Engines in Mining and Milling. A. W. Warwick. Discusses the points needing attention for the economical working of such engines. 4500 w. Min & Sci Pr—March 30, 1901. No. 40167.

STEAM ENGINEERING.

Blowing Engines.

Some Recent Types of Blowing Engines and valves. Illustrated detailed description of the latest developments. 1400 w. Ir & Coal Trds Rev—March 22, 1901. No. 40109 A.

Boilers.

Boilers and Steam Engines at the Paris Exposition. (Les Chaudières et les Machines à l'Exposition de 1900). Ch. Compère. A general review, with details of many of the exhibits. Tables. 2 plates, 18000 w. Mem d l Soc d Ing Civils—January, 1901. No. 40469 G.

Boilers at the Paris Exhibition. Brief illustrated descriptions of exhibits, with comments. 1500 w. Engr, Lond—March 22, 1901. Serial. First part. No. 40113 A.

Boilers at the Paris Exposition. (Die Weltausstellung in Paris, 1900. Die Dampfkessel). Prof. M. F. Gutermuth. A well illustrated general review. Serial. Part I. 1800 w. Zeitschr d Ver Deutscher Ing—March 23, 1901. No. 40402 D.

Steam Boiler Efficiency. William Kent. Abstract of a lecture delivered before the Engng College, Univ of Illinois. Considers the factors of greatest importance. 600 w. R R Gaz—April 19, 1901. No. 40381.

The Belleville Boiler. Editorial discussion of two letters which M. Delaunay Belleville addressed to the secretary of the admiralty. 4000 w. Engng—April 12, 1901. No. 40513 A.

The Montupet Boiler. (La Chaudière Montupet). M. A. Barbet. An illustrated description of a modification of the Field water-tube boiler, remarkable for the simple and efficient manner of fixing the tubes. Tables. 1200 w. Bull Soc d' Encour—March, 1901. No. 40464 G.

The Thornycroft-Marshall Water Tube Boiler. Illustrated detailed description. 1700 w. Prac Engr—April 5, 1901. No. 40285 A.

Water Tube Boilers. W. H. Booth. Discusses the drawbacks which in the writer's opinion condemn these boilers. 1600 w. Am Mach—April 11, 1901. No. 40252.

See Marine and Naval Engineering.

Cooling Towers.

Cooling Towers and the Removal of Oil from Exhaust Steam. A description of a plant reclaiming water in a nearly pure condition, read by F. H. Boyer, before the New England Cotton Mfrs. Assn. 1000 w. Eng Rec—April 27, 1901. No. 40579.

The Klein Water-Cooling Tower. (Réfrigérants à Cheminée, Système Klein). An illustrated description of these cooling towers for condenser water, built entirely of wood. 800 w. Génie Civil—March 23, 1901. No. 40445 D.

Electric Stations.

The Application of Steam Power to the Generation of Electrical Energy. John S. Raworth. Paper read before the Inst of Elec Engs, England, with discussion on the recent development of steam engines due to this use. 4500 w. Elec Rev, Lond—March 22, 1901. No. 40118 A.

Entropy Diagram.

The Study of Steam Engines by Means of the Entropy Diagram. (Études des Machines à Vapeur par le Diagramme Entropique). J. Boulvin. A thermodynamic study of the steam engine with many diagrams and a table. Serial. Part I. 5000 w. Rev d Mec—March, 1901. No. 40477 E + F.

Heat Utilisation.

The Utilisation of Heat in the Steam Engine (Die Ziele und die Erfolge in der Wärmeausnutzung bei der Dampfmaschine). W. Lynen. A paper before the Aachen branch of the Ver Deutsch Ing, giving an illustrated and clear exposition of the principles of thermodynamics, steam engineering, cylinder condensation, etc. Serial. Part I. 6000 w. Zeitschr d Ver Deutscher Ing—March 23, 1901. No. 40401 D.

Lubrication.

On the Subject of Lubrication. W. H. Edgar. Concerning cylinder oils, the selection, the conditions and requirements tests, etc. 1700 w. Marine Rev—April 11, 1901. No. 40310.

Moisture.

Calorimeter Trials for Moisture in Steam. Robert W. King. Shows the importance of calorimeter trials and describes methods. Ill. 2300 w. Can Engr—April, 1901. No. 40294.

Pipes.

Losses of Heat from Underground Pipes. Alton D. Adams. Discusses pipe coverings and the methods of calculating losses. 4000 w. Elec Wld and Engr—April 6, 1901. No. 40209.

Outdoor Steam Pipes. William D. Ennis. Considers the best method of supporting, protecting and insulating pipes carried between two detached buildings. Ill. 2000 w. Power—April, 1901. No. 40123.

Scott Engine.

12 Horse-Power "Scott" Cornish Cycle

Engine. Illustrated description of an engine constructed for driving the automatic stokers at the Battersea electric lighting station. 800 w. Engng—March 29, 1901. No. 40241 A.

Steam Engine.

The Steam Engine at the Beginning of the Twentieth Century. (Die Dampfmaschine bei Beginn des 20. Jahrhunderts). Hr. Straube. A paper before the Karlsruhe branch of the Ver. Deutsch Ing., giving a general review of steam engineering. 5000 w. Zeitschr d Ver Deutscher Ing—April 6, 1901. No. 40407 D.

Steam Meter.

The Gehre Steam Meter. Illustrated description of a meter with autographic register, working on the throttling principle. 1000 w. Eng Rec—April 13, 1901. No. 40305.

Superheating.

Superheated Steam. Ernest H. Foster. Read before the junior meeting of the Am Soc of Mech Engs. A statement of the advantages of superheating as a means of increasing the efficiency of steam plants, and a brief description of types of superheaters now in regular use. 4000 w. Eng Rec—April 6, 1901. No. 40178.

Turbines.

Steam Turbine Applications in Europe. Frank C. Perkins. An illustrated account giving information of uses made of the steam turbine at various places, showing its adaptability for certain classes of work. 4000 w. Jour of Elec—March, 1901. No. 40530.

See Marine and Naval Engineering.

Water Meter.

The Rohkohl Feed-Water Meter. (Compteur d'Eau d'Alimentation pour Chaudières, Système Rohkohl). An illustrated description of a simple piston meter for measuring the water supplied to boilers. 700 w. Génie Civil—April 13, 1901. No. 40463 D.

Water Softening.

Water-Softening Plant at Langwith Colliery. J. G. Shearer. Read before the Inst of Min Engs, England. Illustrated description of the process and apparatus by which very hard water was purified. 1200 w. Mines & Min—April, 1901. No. 40182 C.

MISCELLANY.

Aeronautics.

Aeronautics at the Paris Exposition. (L'Aeronautique à l'Exposition de 1900). Com'd't P. Renard. An account of some remarkable balloon ascensions made in connection with the Exposition; and some very good photographs taken from balloons. 1600 w. Bull Soc d'Encour—March, 1901. No. 40465 G.

Recent Progress in Aerial Navigation. Charles H. Cochrane. Reviews and illustrates attempts at aerial navigation, especially those not well-known. 1500 w. Pop Sci M—April, 1901. No. 40103 C.

The Termination of the Trials of Count Von Zeppelin's Air-Ship. H. W. L. Moedebeck. Describes the technical improvements and the second and third trials, which have demonstrated that it will be possible to navigate the air. 2000 w. Sci Am Sup—April 13, 1901. No. 40260.

The Zeppelin Air-Ship (Das Graf Zeppelin'sche Luftschiff). St. Col. Buchholtz. An illustrated description of the Zeppelin air-ship and some of its predecessors, with an account of the Zeppelin trials in the summer of 1900. 4000 w. Glasers Ann—April 1, 1901. No. 40413 D.

The Zeppelin Air-Ship (Das Zeppelin'sche Ballonproblem). Captain Hermann Hoernes. A well illustrated and complete account of this large air-ship, its construction and its three flights above the Lake of Constance. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—March 22, 29, 1901. No. 40435 each B.

Artillery.

Our New German Field Artillery Guns. Concerning the guns manufactured in Germany for the use of the British field artillery, describing the gun and carriage. 1500 w. Engr, Lond—March 22, 1901. No. 40112 A.

Bibliography.

Industrial Bibliography. (La Bibliographie Industrielle). Jules Garçon. An article calling attention to the necessity for indexes, dictionaries and bibliographies in industrial and scientific work, with a notice of some of the technical catalogues and dictionaries. 4000 w. Bull Soc d'Encour—March, 1901. No. 40467 G.

Bicycles.

The Resistance and Efficiency of Bicycles on Roads (Das Fahrrad im Strassenbaudienste mit Besonderer Berücksichtigung der Oekonomie von Kraft und Zeit). R. Iszkowski. A full discussion of the resistance and operation of bicycles at various speeds and on various grades on different kinds of roads and streets. Tables. Serial. Part I. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—April 6, 1901. No. 40440 D.

Cost Keeping.

The Principles of Cost Accounting. F. A. Halsey. A discussion of cost systems, the importance and object. 8000 w. Sib Jour of Engng—April, 1901. No. 40519 C.

Education.

Instruction in Foundry Practice at the University of Illinois. D. T. Randall. Illustrated description of the shops, appliances and instruction given. 1000 w. Jour

Am Found's Assn—April, 1901. No. 40133.

The Education of Mechanical Engineers and Chemists in the Higher Technical Schools of Russia. (Die Ausbildung der Maschineningenieure und Chemiker in den Höheren Technischen Lehranstalten Russlands). M. Sserebroffsky and G. v. Doepp. A general account of the Russian technical schools and their curricula. 4000 w. Zeitschr d Ver Deutscher Ing—April 6, 1901. No. 40406 D.

Evaporator.

Tests of Quiggin Evaporators, in Single, Double and Triple Effect. W. Everett Parsons. An account of tests made to determine the economy of producing distilled water for ice-making purposes. 2200 w. Stevens' Ind—April, 1901. No. 40370 D.

Glasgow Exhibition.

Scope and Significance of the Glasgow International Exhibition. Benj. Taylor. Summarizes the purposes, outlines the buildings and arrangement, and gives a synopsis of the power plant and electrical equipment. Ill. 3200 w. The Engineering Magazine—May, 1901. No. 40453 B.

Heating.

A Hot-Blast Furnace Heating Installation. Illustrated description of apparatus for heating a public hall by blowing air through hot-air furnaces. 600 w. Eng Rec—April 20, 1901. No. 40364.

Metric Screw Thread.

International Metric Screw-Thread System. (Internationales Gewindesystem auf Metrischer Grundlage). A description, with diagram and table of the system adopted by the Ver. Deutsch. Ing., the Société d'Encouragement pour l'Ind. Nat. and the Ver. Schweiz. Masch. Industrieller at Zürich, Oct., 1900. 800 w. Zeitschr d Oesterr Ing u Arch Ver—April 12, 1901. No. 40437 B.

Nineteenth Century.

Progress and Tendency of Mechanical Engineering in the Nineteenth Century. Robert H. Thurston. An address before the Washington Acad. of Sciences, Columbian University. 4300 w. Pop Sci M—May, 1901. Serial. First part. No. 40576 C.

Paris Exposition.

The Mechanical Installation at the Paris Exposition (Installations Générales du Service Mécanique de l'Exposition Universelle et Internationale de 1900). Charles Bourdon. A complete account of the organization of the mechanical service, the power plant, the distribution of water, etc., ventilation, etc. Two plates. 13000 w. Mem d l Soc d Ing Civils—January, 1901. No. 40468 G.

Plenum System.

A Plenum Fan System of Heating in an Exposition Building. Illustrated description of the forced blast system of the New York State Building at the Pan-American Exposition. The building is a permanent structure and the plant is designed to keep the temperature at 70 degrees with the outside air 10 degrees below zero, and to change the air every 10, 15 or 20 minutes, according to the nature of the occupancy. 1600 w. Eng Rec—April 13, 1901. No. 40306.

Refrigeration.

Refrigerating Machines at the Paris Exposition. (Die Weltausstellung in Paris, 1900. Die Kältemaschinen). R. Schöttler. An illustrated general review, with particular descriptions of various details. 2500 w. Zeitschr d Ver Deutscher Ing—March 23, 1901. No. 40400 D.

Sugar Plant.

The Beet Sugar Plant at Fremont, O. Illustrated description of plant with new apparatus for rapid crystallization of low products and new forms of centrifugals, with notes on a method of utilizing the poor molasses now run to waste. 900 w. Eng Rec—April 13, 1901. No. 40303.

Ventilation.

Improvements in the Ventilation of the Law Courts. An outline of the improvements made including the adoption of the Davidson "Sirocco" fans. 1500 w. Engr, Lond—April 12, 1901. No. 40517 A.

Ventilating and Heating a Restaurant. Illustrated description of a plant in which fresh air is forced through direct radiators to ventilate a restaurant in the basement of a large office building. 900 w. Eng Rec—April 27, 1901. No. 40585.

MINING AND METALLURGY

COAL AND COKE.

British Columbia.

The Coal Creek Colliery of the Crow's Nest Pass Coal Co. C. V. Corless. Read before the Canadian Min. Inst. Illustrated description of the mines and their working, production, etc. 5500 w. Can Min Rev—March 31, 1901. No. 40166 B.

Coke Ovens.

Improved Heminway Process of Coking Coal in Beehive Coke Ovens. R. S. Moss. Illustrates and describes the process as used at the plant of the Universal

Fuel Co., Chicago, Ill. 3400 w. Mines & Min—April, 1901. No. 40187 C.

The New Coke Plant of the Eureka Fuel Company in the Klondike Region, Pennsylvania. J. P. Brennen. Illustrates and describes a complete modern plant. 2300 w. Mines & Min—April, 1901. No. 40180 C.

See Gas Engineering.

Fans.

Rope Driven versus Direct Driven, Colliery Ventilating Fans. Francis T. Peacock. On the conditions which should determine a selection of the type to be used, and the advantages of each. 2400 w. Can Min Rev—March 31, 1901. No. 40165 B.

France.

Coal, Iron and Steel Production of France. Statistics giving an estimate of the coal, lignite, iron, and steel produced in France during 1899 and 1900. 600 w. U S Con Repts, No. 1021—April 26, 1901. No. 40545 D.

Geology.

The Permo-Carboniferous Boundary and What We Learn About It from the Sealand and Thurgarton Boreholes. W. J. Clarke. Abstract of a paper read before the Chester Soc. of Nat. Science. On means of determining the dividing line between the permian and carboniferous formations. 1500 w. Col Guard—April 4, 1901. No. 40335 A.

Nova Scotia.

Coal Mining in Nova Scotia. Concerning the production and new developments. 800 w. Eng & Min Jour—April 20, 1901. No. 40372.

Pennsylvania.

The Coal-Field of Somerset County, Pa. W. G. Irwin. Information concerning the most important mines, and the transportation facilities. 1100 w. Eng & Min Jour—April 27, 1901. No. 40591.

Spontaneous Ignition.

Storage and Spontaneous Ignition of Coal. Herr Sohren. Abstract of a paper read before the German Gas Assn. Discusses the subject of spontaneous ignition, reviewing the early investigations and recent work, and giving Dr. Munk's recommendations. 1700 w. Gas Wld—April 13, 1901. No. 40500 A.

United States.

Growth of the Coal Industry in the United States. From a report issued by the United States Government; giving a review of the progress, the geographical distribution, and related information. 5000 w. Col Guard—March 22, 1901. No. 40115 A.

Vancouver.

The Vancouver Coal Mines. An account of quite a number of changes in the mines of Vancouver Island during the past year. 1000 w. U S Cons Repts. No. 1020—April 25, 1901. No. 40526 D.

COPPER.

Lake Superior.

Early Copper Days of Lake Superior. Graham Pope. Read before the Lake Superior Min. Inst. Interesting historical review of the copper mining industry in this region. 6000 w. Marine Rev—March 28, 1901. No. 40092. .

The Lake Copper Industry. H. J. Stevens. How it has expanded within a few years by the opening of new mines and the equipment of new mills. 2200 w. Mines & Min—April 1901. No. 40185 C.

Smelting.

The History of Copper Smelting in the Lake Superior Region. James B. Cooper. Abstract of a paper read before the Lake Superior Min. Inst., reviewing this industry. 1100 w. Eng & Min Jour—April 27, 1901. No. 40592.

Southern United States.

Valuable Opportunities in Southern Copper. C. F. Z. Caracristi. A review of this region showing at least three copper deposits of proved value, and copper in greater or less quantity in all Southern States. Gives information to investors. Ill. 7000 w. Mfrs Rec—April 18, 1901. No. 40341.

GOLD AND SILVER.

Australia.

Gold Mining and Milling in Western Australia. A. G. Charleton. This fourth paper of the series deals with mining methods, extent and rate of development, costs, and special conditions encountered. Ill. 6300 w. The Engineering Magazine—May, 1901. No. 40455 B.

British Columbia.

The North Star Mine and Nickel Plate Mine of British Columbia. J. M. Turnbull. Read before the Applied Science Soc of McGill Univ. Details of the operation of these silver mines. 4000 w. Can Engr—April, 1901. No. 40295.

Colorado.

The Liberty Bell Mine. A description of the mine, gold and silver ores, difficulties in successfully treating them, methods of transportation, etc. Ill. 2000 w. Mines & Min—April, 1901. No. 40186 C.

Dredging.

Dredging Fine Gold. Fred. Shury. Explains how the mixing-tank system can be successfully worked in dredging beach gold. Ill. 1700 w. N Z Mines Rec—Feb. 16, 1901. No. 40292 B.

Gold Dredging. F. C. Nettleton. Discusses the things which should be considered in installing a plant, some of the

difficulties and how they may be met. 2000 w. Mines & Min—April, 1901. No. 40189 C.

Leaching.

Modern Leaching Processes. J. Ohly. Describes various leaching processes due to the variety of ores to be treated. 2300 w. Min & Sci Pr—April 6, 1901. No. 40266.

Mispickel.

The Treatment of Auriferous Mispickel ores at Deloro, Ontario. Two papers read before the Canadian Min Inst. One by P. Kirkegaard, the other by Sydney B. Wright. Concerning the mining, milling and particulars of treatment. 7500 w. Can Min Rev—March 31, 1901. No. 40163 B.

Permanganate Process.

Prof. Black's Permanganate Process. Dr. H. Norman. A description of the important phases of this discovery, and a statement of its chief points of advantage over the chlorination process. 3000 w. Min & Sci Pr—April 6, 1901. No. 40265.

IRON AND STEEL.

Armor Plate.

Armor Plate at the Paris Exposition. (Les Blindages à l'Exposition de 1900). L. Baclé. A comprehensive review of armor plate as shown at the Exposition, with detailed accounts of some of the plates. Serial. Part I. 4500 w. Génie Civil—April 13, 1901. No. 40462 D.

Australasia.

Iron Making in Australasia. Information concerning the supply in New South Wales, Victoria, New Zealand, Tasmania and South Australia. 2800 w. Ir & Coal Trds Rev—April 12, 1901. No. 40508 A.

Cannon Steel.

Official Testing of Steel for Cannon in France and in the United States. (Essais Officiels de Réception des Aciers à Canon en France et aux Etats-Unis). M. S. Heryngfet. Description of methods of testing, with results of tests. Tables. 5000 w. Mem d l Soc d Ing Civils—February, 1901. No. 40471 G.

France.

See Mining and Metallurgy, Coal and Coke.

Pig Iron.

The Sampling and Grading of Pig Iron. Herbert E. Field. Describes method and shows its accuracy. 1500 w. Found—April, 1901. No. 40136.

Spain.

Development of Iron Ore Mining and its Manufacture in the Central Portion of the north of Spain. John Alcock Jones. A review of the provinces of Lugo, and Leon, and the principality of Asturias. Maps. 2400 w. Ir & Coal Trds Rev—April 5, 1901. Serial. 1st part. No. 40336 A.

Steel Industry.

Britain and Her Competitors in Iron and Steel Making. E. Phillips. A comprehensive review of contrasting physical and economic conditions in Britain and America, with summary of their nett influence on the cost of steel making. Serial. 1st part. 6500 w. Engineering Magazine—May, 1901. No. 40451 B.

Steel Works.

The Steel-Works, Wire-Works and Sheet Mills of Dorman, Long & Co., Middlesborough. An illustrated account of important English works. 3200 w. Ir & Coal Trds Rev—April 5, 1901. No 40337 A.

Tool Steel.

Tool Steel (Rundschau). A review of the Taylor-White tool steel, made at Bethlehem, Pa., and explanation of the way the cutting tool retains its sharpness, and a table comparing the operation of tools made of this steel with those of other steels. 1800 w. Zeitschr d Ver Deutscher Ing—March 30, 1901. No. 40404 D.

MINING.

China.

Prospecting in China. Auguste Mathez. Describes the country north of Peking, and its inhabitants. Ill. 2700 w. Mines & Min—April, 1901. No. 40183 C.

Compressed Air.

Compressed Air in Mining. J. E. Bell, in *Mining and Metallurgy*. On the cost of compressed air per indicated horse-power, claiming that a large air-compressing plant could be made with a conservative estimate of 75 per cent. of the cost of an electric plant of a like size. 4800 w. Compressed Air—April, 1901. No. 40232.

Colorado.

Mining in Colorado. H. A. Lee. Epitome of report of the State Bureau of Mines, Colorado, 1899-1900. 1800 w. Mines & Min—April, 1901. No. 40188 C.

Electric Blasting.

Electric Shot-Firing in Quarries. Gives some reasons for adopting it. 2800 w. Quarry—April, 1901. No. 40589 A.

Oil Engines.

See Mechanical Engineering, Gas and Oil Engines.

Philippines.

The Uses of Native Woods in Mining in the Philippines. Describes improvements in rope-haulage, introduced in the mines newly equipped by foreign capitalists, the wheels being constructed of "bullet" wood of the islands. Also other uses to which the wood is adapted, and information concerning the native workmen and their methods. Ill. 1700 w. Eng & Min Jour—April 6, 1901. No. 40214.

Safety Lamps.

Miners' Electrical Safety Lamps. Sydney F. Walker. Read before the Inst. of Elec. Engs., England. Gives particulars of a number of attempts at producing a safety lamp to meet the needs of miners, discusses the difficulties, and the advantages a reliable electric lamp would possess. 3500 w. Ir & Coal Trds Rev—March 29, 1901. Serial. 1st part. No. 40247 A.

Scotland.

Mining Practice in Scotland. David Rankin. Read before the Glasgow Assn. of students. Considers the letting of mineral fields, proving, fitting, working, surveying, checking rental returns, valuing of minerals and of works and accessories as related to the duties of the mining engineer. 3000 w. Col Guard. March 29, 1901. No. 40263 A.

Shaft Sinking.

Sinking No. 5 Shaft at the Tamarack Mine, Michigan. William E. Parnall, Jr. Read before the Lake Superior Min. Inst. Illustrates and describes the work of sinking a shaft 4,684 feet deep, which occupied 4½ years. 3000 w. Eng & Min. Jour—April 13, 1901. No. 40308.

Steel Construction.

Steel Construction for Mines. From an address by Mr. Jackson, at a meeting of mine managers in Ishpeming, on the use of steel instead of wood in buildings, shafts, &c. 3600 w. Marine Rev—April 4, 1901. No. 40199.

Timbering.

Methods of Preventing Falls of Roof Adopted at the Courrières Collieres. Report of a committee sent to investigate the special methods adopted in these French collieries which have resulted there in a remarkable diminution of the number of accidents. Ill. 9000 w. Col Guard—March 22, 1901. No. 40114 A.

Tunnel.

See Civil Engineering, Construction.

MISCELLANY.

Aluminum.

The Progress of Aluminum. The first of a series of articles on the headway made by this metal during the last year. 2200 w. Engr, Lond—March 22, 1901. Serial. 1st part. No. 40110 A.

Bismuth.

Bismuth Assay. A. W. Warwick and T. D. Kyle. Discusses the inaccuracies of the usual methods of assaying bismuth, and recommends a modification of the process devised by Pattison Univ. 1300 w. Eng & Min Jour—April 13, 1901. No. 40307.

Briquetting.

The Briquetting of Pulverulent Ores (Agglomération des Minerais Pulvérulents). A. Lapanche. An illustrated description of methods of forming finely divided ore into briquettes for convenience in metallurgical treatment. 1 Plate. 2200 w. Génie Civil—April 13, 1901. No. 40451 D.

Geology.

Peculiar Geological Formations of the Southern States. Arthur Lakes. Considers the circumstances which cause them, and their relation to vein formation and mining. 1600 w. Mines & Min—April 1, 1901. No. 40190 C.

Petroleum.

Significance of the Texas Oil Field. An account of this wonderful discovery, the enormous production, its convenient location for transportation, the character of the oil, other fields, etc. 8300 w. Mfrs' Rec—April 11, 1901. No. 40268.

The Oil-Fields of Baku. G. Frederick Wright in *The Nation*. Information concerning these fields near the Caspian Sea, the extent, production, transportation, facilities, etc. 1400 w. Sci Am Sup—April 6, 1901. No. 40218.

The Russian Petroleum Trade. On the production of crude oil at the Baku fields, the price at the wells, refining, consumption, transportation, etc. 7700 w. U. S. Cons Repts. No. 1002—April 4, 1901. No. 40156 D.

Philippines.

The Unexplored Mineral Resources of the Philippines. Frank L. Strong. An interesting explanation of the illusory and unreliable character of the Spanish data and surveys and of the scantiness of exact information, with a general statement of the resources, so far as actually known. 1800 w. The Engineering Magazine—May, 1901. No. 40456 B.

Salting.

Salting of Ore Samples. An account of a sensational case in Australia. 4800 w. Aust Min Stand—Feb. 28, 1901. No. 40296 B.

Turquoise.

The Turquoise Mines of the Cerrillos Mountains in New Mexico. Arthur Lakes. Describes these mines which are said to be the largest producers in the world. 1400 w. Mines & Min—April, 1901. No. 40184 C.

Zinc.

The Zinc Problem at Georgetown, Colo. On the treatment of zinc blende, and other zinc ores. 700 w. Min Rept—April 18, 1901. No. 40384.

Zinc-Lead.

The Zinc-Lead Deposits of Southwest Arkansas. William B. Phillips. Describes these mines and the work already accomplished. 1400 w. Eng & Min Jour—April 6, 1901. No. 40213.

RAILWAYS AND TRAMWAYS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in February. Detailed list and classified summary. 3900 w. R R Gaz—April 5, 1901. No. 40203.

Road Material.

Electric Railways for the Transportation of Road Material. A statement, by F. P. Cobb, of the advantages of hauling road materials on street railways and permitting cars so loaded to run on the tracks of more than one company. 1000 w. Eng Rec—April 27, 1901. No. 40587.

Rules.

Report of Committee on Interchange Rules. Gives the report of the committee and its discussion. 8000 w. Cent Ry Club—March, 1901. No. 40160 C.

Train Sheets.

The Use of the Train Diagram in Determining the Best Location of Power-House and Sub-Stations for Interurban Railways. Edward P. Roberts. An outline of the more usual factors to be considered in connection with the design of an interurban electric road, indicating something of the value of a train sheet. 5500 w. Stevens Ind—April, 1901. No. 40366 D.

Trolley.

The Trolley Age. Albert L. Johnson, in *The Independent.* Considers the electric system of transportation will make it possible to greatly reduce rates and give rapid service. 1500 w. Sci Am Sup—April 27, 1901. No. 40542.

FINANCIAL.

French Tramways.

The Economy of Electric Traction in France (Résultats Economiques de la Substitution de la Traction Electrique à la Traction Animale). Charles Jean. An article with many tables showing statistics and financial results of the substitution of electric for animal traction in six French cities. 3000 w. Génie Civil—March 30, 1901. No. 40447 D.

Railroad Taxation.

What Is the Value of a Railroad for Purposes of Taxation? Charles Hansel. A discussion of the work of Prof. M. E. Cooley, who was selected to examine and report on the railroad properties of the State of Michigan, and the subject in general. 2500 w. R R Gaz—April 19, 1901. No. 40383.

MOTIVE POWER AND EQUIPMENT.

Accumulator Car.

The Use of Accumulator Cars on Standard Railways (Verwendung von Akkumulatoren für den Omnibusbetrieb auf Hauptbahnen). Hr. Gayer. A paper before the Verein für Eisenbahnkunde, giving an illustrated account of the operation of accumulator cars in local service about Ludwigshafen, Worms and Neustadt, Germany, with diagrams. 3 plates. 5000 w. Glasers Ann—March 15, 1901. No. 40412 D.

Air Brakes.

Air-Brake Efficiency. Continued discussion of this subject. 15300 w. Cent. Ry Club—March, 1901. No. 40159 C.

Armored Train.

See Mechanical Engineering, Automobilism.

Berlin.

The Electric Operation of the Berlin "Ringbahn" (Der Elektrische Betrieb auf der Berliner Stadt und Ringbahn). Hr. Schimpff and Prof. Kübler. A discussion of the substitution of electricity for steam on the city railway of Berlin. The subject is considered from every side and electrical operation is strongly recommended. 5000 w. Glasers Ann—April 1, 1901. No. 40414 D.

Box Cars.

40-Ton Box Cars with Steel Underframes. Illustrates and describes cars for the Union Pacific R. R. 300 w. Am Engr & R R Jour—April, 1901. No. 40142 C.

60,000-lb. Capacity Box Car with Pressed Steel Underframe—Philadelphia & Reading Railroad. Description, photograph and line drawings. 1100 w. R R Gaz—March 29, 1901. No. 40095.

Brake.

Hydraulic Electric-Car Brake. Illustrated description of what is known as the Neal-Duplex brake, which is operated on the hydraulic principle. 800 w. Sci Am—April 6, 1901. No. 40217.

Car Framing.

A System of Steel Framing for Freight Cars. G. W. Scott. Illustrated description of a system of underframing and a discussion of the requirements fundamental in car design. General discussion follows. 10500 w. Pro W Ry Club—March, 1901. No. 40269 C.

Compressed Air.

I. Railroad Uses of Pneumatic Tools. Ill. Thomas Aldcorn. II. Compressed Air in Railroad Service. W. P. Pressinger. Two papers, discussed together, on the uses for compressed air in railroad work. 12800 w. N Y R R Club—March 21, 1901. No. 40281.

Connecticut.

Some Wrinkles on the Fair Haven & Westville Railroad. Illustrated description of the tower car, motor testing device and pit jack and rack. 900 w. St Ry Jour—April 6, 1901. No. 40196 D.

Dining Car.

A Modern Dining Car—C. B. & Q. Railway. Illustrated description of new cars possessing novel features. 600 w. Ry Mas Mech—April, 1901. No. 40139.

Draft Gears.

Road Tests of Draft Gears. A report of tests made on the Chicago division of the Atchison, Topeka and Santa Fe Railway. 1000 w. Am Engr & R R Jour—April, 1901. No. 40146 C.

The Atchison Draft-Gear Tests. H. H. Westinghouse. A letter disagreeing with the conclusions editorially expressed concerning the results of these tests. 1100 w. R R Gaz—April 19, 1901. No. 40379.

Electric Locomotives.

Electric Mine Locomotives. W. B. Clarke. Things to be observed in the choosing, operating and caring for mine locomotives to ensure the greatest economy. Ill. 3600 w. Mines & Min—April, 1901. No. 40181 C.

Electro-Magnetic Tramway.

Electric Traction Independent of Adhesion (Traction Electrique Indépendante de l'Adhérence). F. D. A brief, illustrated description of a polyphase system of traction on the principle of a "travelling magnetic field," in which the car carries what corresponds to the "rotor" and the sectional "stator" is disposed along the line. The car is then pulled along by the attraction of the moving magnetic field. 500 w. Génie Civil—April 6, 1901. No. 40459 D.

Furniture Car.

50-Ft. Furniture Car with Steel Underframing—Erie Railroad. Illustrates and describes cars of 60,000 lbs. capacity, of interest because of its dimensions and composite structure. 1060 w. R R Gaz—April 26, 1901. No. 40572.

Grates.

Large and Small Grate Areas and Combustion. A. Bement. Discusses the advantages of frequent, light firing and shaking of grates, studied by gas analysis. 2000 w. Am Engr & R R Jour—April, 1901. No. 40143 C.

Locomotives.

A Creusot High-Speed Locomotive. From *La Nature*. Illustrated description of engine constructed after plans of M. Henri Thuile built with the object of attaining speeds of 72 miles and commercial speeds of about 60 miles for the hauling of 200 tons. 600 w. Sci Am Sup—April 13, 1901. No. 40262.

American Locomotives for South Africa. Brief illustrated description of ten-wheel passenger engines for the Cape Government Ry's of Cape Colony. 300 w. Eng News—April 25, 1901. No. 40562.

An Engine Built in 1832. Herbert T. Walker. A drawing of the engine "Pioneer," with information concerning it. 1200 w. R R Gaz—April 12, 1901. No. 40273.

Austro-Hungarian Compound Locomotives at the Paris Exposition (Les Locomotives à l'Exposition de 1900: Locomotives Compound de la Société Austro-Hongroise des Chemins de Fer de l'Etat). F. Barbier. An illustrated description of some ten-wheel, compound locomotives. 1000 w. Génie Civil—April 6, 1901. No. 40449 D.

British Locomotives in 1900—Designs and Work. Charles Rous Marten. From the Bulletin of the International Ry. Cong. 2000 w. R R Gaz—April 26, 1901. No. 40574.

"Chautauqua" Type Passenger Locomotive. Illustrated description of a fast locomotive built for the Chicago, Rock Island, and Pacific Ry. 1500 w. Am Engr & R R Jour—April, 1901. No. 40141 C.

Express Locomotive: Krauss System. Illustrated description of an engine exhibited at the Paris Exhibition. A twelve-wheeled express engine, of which four wheels were coupled. It was fitted with auxiliary motor wheels (system Krauss), and had a truck at each end. 1100 w. Engng—April 12, 1901. No. 40511 A.

Express Passenger Engine, Great Central Railway. Illustrated description of a single-wheeled bogie engine with tender designed for service on the new London extension line. 1500 w. Engr, Lond—April 12, 1901. No. 40518 A.

Express Passenger Engine, Mediterranean Railway of Italy. Illustrated detailed description of an engine exhibited at Vincennes. 1600 w. Engr, Lond—April 5, 1901. No. 40333 A.

Locomotives at the Paris Exposition (Les Locomotives à l'Exposition de 1900). F. Barbier. A well-illustrated

description of a high-speed, ten-wheel, compound locomotive, built by the Chemnitz (Saxony) works. 1 plate. 2000 w. Génie Civil—March 23, 1900. No. 40-444 D.

Mogul Fast Freight Locomotives. Illustrated description of simple and compound engines with wide fireboxes, for the Atchison, Topeka & Santa Fe Ry. 450 w. Am Engr & R R Jour—April, 1901. No. 40145 C.

New Passenger Locomotives for the Lake Shore & Michigan Southern. Illustrated description of new wide fire-box locomotives. 800 w. R R Gaz—March 29, 1901. No. 40096.

Tests of Wide and Narrow Fire-Box Locomotives. Gives results of road tests, burning soft coal, which furnish the most recent and thorough facts concerning wider grates. Also editorial. 3700 w. R R Gaz—March 29, 1901. No. 40094.

The Locomotive of the Future—A Suggestion. Discusses the advisability of removing the engines and driving-wheels to the tender. 1100 w. Sci Am—April 27, 1901. No. 40539.

Two New Schenectady Consolidation Locomotives. Illustrates and describes two engines for freight service, one on the Southern Pacific, the other on the Boston & Maine R. R. 1800 w. Ry & Engng Rev—March 30, 1901. No. 40154.

Wide Fire-Box Passenger Locomotives for the Chicago, Rock Island & Pacific Railway. Illustrated description, with general dimensions of a locomotive for burning bituminous coal. 700 w. R R Gaz—April 26, 1901. No. 40570.

Locomotive Building.

Locomotive Building in the United States. John H. Converse. An account of the development of this industry, taken from a statement made to the Industrial Commission. 2700 w. Ir Age—April 4, 1901. No. 40155.

Motors.

The Service Capacity of Railway Motors. A. H. Armstrong. Considers method of predetermining the fitness of a railway motor for a given service. 4000 w. St Ry Jour—April 6, 1901. No. 40-198 D.

Motor Construction.

The Construction of an Electric Tramway Motor. S. H. Short. Illustrates and describes the various processes through which the steel, iron and copper must go to make a complete modern motor. 1100 w. Elec Rev, Lond—March 29, 1901. Serial. 1st part. No. 40228 A.

Motor Tests.

Comparative Tests of Street Railway Motors. C. H. Bigelow. Read at Boston meeting of the New England St. Rv. Club. A report of comparative tests between four-motor and two-motor cars. 1600 w. Elec, N. Y.—April 10, 1901. No. 40255.

Ore Car.

Improved Ore Car, 100,000 Pounds Capacity. Illustrated description of a hopper ore car for the Chicago, Milwaukee and St. Paul Railway. 450 w. Am Engr & R R Jour—April, 1901. No. 40147 C.

Packing.

Best Method of Preparing Journal Box Packing. J. W. Bunn. Illustrated description of vats for treating packing. 900 w. Ry Mas Mech—April, 1901. No. 40140.

Steel Car.

Special Steel Car, Northern Ry. of France. Illustrated description of a special design of freight car equipment for the transportation of heavy machinery. 800 w. Ry & Engng Rev—April 20, 1901. No. 40386.

Throttle-Valves.

The Design of Locomotive Throttle Valves. A discussion of a "compensating" throttle-valve, invented by J. S. Chambers. 1900 w. Eng News—April 25, 1901. No. 40566.

Train de Luxe.

A Train de Luxe for Rhodesia. Illustrated description of a magnificent train for first-class passenger traffic. 700 w. Transport—April 12, 1901. No. 40398 A.

Train Lighting.

Train Lighting by Electricity. George D. Shepardson. Briefly reviews the history of train lighting and the advantages of electric lights, and notes the various plans that have been tried. Ill. 7400 w. St. Louis Ry Club—March 8, 1901. No. 40134.

Tramcars.

Tramcar Construction. Illustrated description of the work taken from an interesting pamphlet issued by a British firm. 2200 w. Elec Engr, Lond—March 22, 1901. No. 40116 A.

War Car.

The Simms 6-H. P. Petrol Motor and War Car. Illustrates and describes a car built to run upon the permanent ways of any railroad system, intended for making inspections or sending despatches, and for the protection of the railway generally. 1000 w. Auto Jour—April, 1901. No. 40550 A.

NEW PROJECTS.

California--Utah.

Railroads Between Los Angeles and Salt Lake City. An account of two lines claiming the same right of way, giving

an outline of the history of the contest. 1200 w. R R Gaz—April 26, 1901. No. 40575.

Interurban.

Interurban Electric Railroad Development in Northern Ohio. An account of the connecting of detached systems forming interurban lines and, ultimately, extended trunk lines between large centers, and the problems in consequence. 1500 w. R R Gaz—April 26, 1901. No. 40573.

Trans-Siberian.

Review of Progress on the Trans-Siberian. L. Lodian. Illustrated notes taken on a 366-day inspection tour. 3000 w. Loc Engng—April, 1901. Serial. 1st part. No. 40128 C.

PERMANENT WAY AND FIXTURES.

Albany Improvements.

New York Central Improvements at West Albany. Illustrations giving a general idea and some details of the new yards, round-houses and accessories, a coal stocking plant, and a coal trestle, on the N. Y. C. & H. R. R. R. 900 w. R R Gaz—March 29, 1901. No. 40093.

British Guiana.

The New Electric Railway at Georgetown, British Guiana. Brief description of the city and the conditions to be met, with an account of the construction and equipment of the line. 2000 w. St Ry Jour—April 6, 1901. No. 40197 D.

Brooklyn Bridge.

The Brooklyn Bridge Terminal Problem. Editorial discussion of the plans proposed in 1888 by A. M. Wellington, the changed conditions since then, and some suggestions suited to the present problem. 3000 w. Eng News—April 11, 1901. No. 40279.

Conduit Tramway.

An Electric Tramway with Side Conduits (Tramway Electrique à Caniveau Latéral). Henry Martin. A well illustrated description of a Paris tramway, with the conduit under one of the rails, running from the Bastille to St. Ouen. 1 plate. 3000 w. Génie Civil—April 6, 1901. No. 40448 D.

Crossings.

Crossings of Steam and Electric Railways. Report of the Am. Ry. Engng. and Main. of Way Assn., relating to the safety of highway surface crossings of railways. 1800 w. St Ry Rev—April 15, 1901. No. 40388 C.

Cuts.

Some Ideas on Side-Hill Cuts. Henry W. Allen. Points of information on cuttings for roadbed in side-hills. Ill. 900 w. Ry & Engng Rev—April 13, 1901. No. 40291.

Indiana.

See Electrical Engineering, Generating Stations.

Liverpool.

The Street Railway System of Liverpool, England. Illustrated description of the tramway scheme, the power plants also supplying energy for electric lighting. 6700 w. St Ry Jour—April 6, 1901. No. 40192 D.

Michigan.

The System of the Michigan Traction Company and the Power House of the Kalamazoo Valley Electric Traction Company. Brief illustrated description. 1500 w. St Ry Jour—April 6, 1901. No. 40194 D.

Naples.

The Street Railway System of Naples. Cesare Pio. Brief illustrated account of the electrical equipment of the street railway lines. 1400 w. St Ry Jour—April 6, 1901. No. 140193 D.

Rails.

A Criticism of the Report of the Board of Trade Committee on Steel Rails. John Oliver Arnold. Abstract of a lecture delivered before the Sheffield Soc. of Engs. and Met. Ill. 1700 w. Ir & Coal Trds Rev—April 12, 1901. No. 40509 A.

Seattle.

Notes on Seattle Street Railway Practice. Illustrates and describes the soldered bonds used, the block signals, snow drags, bracket construction, etc. and gives information concerning the operation. 2400 w. St Ry Jour—April 6, 1901. No. 40195 D.

Shops.

Bloomington Shop Improvements. Illustrated description of improvements on the Chicago & Alton Railroad. 1000 w. Am Engr & R R Jour—April, 1901. No. 40144 C.

Siam.

The Railroads of Siam. An illustrated account of the roads, their construction and importance. 1200 w. Ry Age—April 12, 1901. No. 40313.

Single Rail.

The Lehmann Single-Rail Road (Die Einschienenbahn von A. Lehmann). Prof. A. Birk. A well-illustrated description of this single-rail system for industrial and field tramways, principally for freight. 1 plate. 1800 w. Oesterr Wochenschr f d Oeffent Baudienst—April 6, 1901. No. 40441 D.

Sleepers.

Cast Iron Sleepers on the Madras Ry. Extracts from the report of E. W. Stoney on the relative life and cost of timber and cast iron sleepers, with illustration of de-

tails of the design used. 1200 w. Ry & Engng Rev—April 6, 1901. No. 40234.

Snow.

Snow Upon Railways. From L'Illustration. Brief account of the methods employed for removing the accumulation of snow. Ill. 1700 w. Sci Am Sup—March 30, 1901. No. 40102.

Station Grounds.

Decoration of Station Grounds on the Philadelphia and Reading. Illustrates the grounds at several stations and gives details of the practice of this company. 600 w. Ry & Engng Rev—April 6, 1901. Serial. 1st part. No. 40233.

Switches.

Facing-Point Switch Protection, L. S. & M. S. Ry. Illustrated description of a signal lever attachment to the switch stand, arranged to be interlocked with the switch points, adopted as the standard device for the protection of facing-point switches on the road named. 900 w. Ry & Engng Rev—April 20, 1901. No. 40385.

Trestle Filling.

Relative Cost of Filling Trestles. I. O. Walker. Extracts from a paper in the Pro. of the Engng. Assn. of the south, describing and discussing work done on the N., C., and St. L. R. R. 2800 w. R R Gaz—April 19, 1901. No. 40382.

Trestle Filling on the N. C. & St. L. Ry. Extracts from a paper by I. O. Walker, presented before the Engng. Assn. of the South. Illustrated description of work on one of the divisions of this road. 2300 w. Ry & Engng Rev—April 13, 1901. No. 40289.

Trolley and Conduit.

Combined Trolley and Conduit Tramway Systems. A. N. Connett. Read before the Inst. of Mech. Engs., London, with discussion. Considers means of solving the problem when the current must in certain places be furnished otherwise than from the overhead wire; especially studying the open-slot conduit. Ill. 4300 w. Engng—March 22, 1901. Serial. 1st part. No. 40107 A.

Tunnels.

See Civil Engineering. Construction.

Wooden Railways.

Wooden Railways. W. B. Paley. Description, with illustrations, of some of the wooden railways built and their service. 1900 w. Sci Am Sup—April 6, 1901. No. 40219.

TRAFFIC.

Differentials.

Railroad Discrimination Against New York, and the Remedy. Abel E. Blackmar. Treats of discrimination against a locality in the interests of a carrier, and the rate problem. Discusses the differential agreement. 4800 w. Pro Am Soc of Civ Engs—April, 1901. No. 40522 E.

Long and Short Haul.

Long and Short Haul. Supreme Court decision in the East Tennessee, Virginia and Georgia case, involving rates to Nashville and Chattanooga. 6000 w. Ry Age—April 19, 1901. No. 40371.

MISCELLANY.

Canada.

The Railways of Canada. Interesting statistics showing great progress. 1400 w. U. S. Cons Repts, No. 1001—April 3, 1901. No. 40127 D.

European Railways.

European Railway Jottings. Charles Rous-Marten. Illustrates the engines that drew the funeral train of the Queen, also the latest Great Western engine. 2300 w. Loc Engng—April, 1901. No. 40129 C.

Great Britain.

The Railway Situation in Great Britain. J. W. Root. A discussion of railway conditions, and the problems to be solved, with suggestions for reforms. 6000 w. Ry Age—April 12, 1901. No. 40312.

Paris Exposition.

Railway Affairs at the Paris Exposition (Das Eisenbahnwesen auf der Letzten Pariser Weltausstellung). Hr. Kriesche. A paper and discussion before the Verein für Eisenbahnkunde on Paris terminal stations, American locomotives, weights of freight cars, turn-tables, etc. 4500 w. Glasers Ann—March 15, 1901. No. 40411 D.

Prussia.

The Development of the Prussian Railway System (Die Entwicklung des Preussischen Eisenbahnwesens). An abstract of an interesting debate in the Prussian House of Deputies on the management and equipment of the state railways; and also interviews with prominent technical men on the same subject. 9000 w. Zeitschr d Ver Deutscher Ing—April 13, 1901. No. 40409 D.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to JOHN R. DUNLAP, PUBLISHER.

Fuel Combustion.

A Catechism of the Combustion of Coal and the Prevention of Smoke. By William M. Barr, M. E. Price, $1.50; pp. 350. New York: Norman W. Henley & Co.

Applies the catechetical method to discussion of the generation of heat, in stationary and locomotive steam-boiler practice, from the fuels commonly found in the United States. Adapted to the use of engineers and firemen. With 85 engravings.

Iron.

Grundzüge der Siderolgie für Hüttenleute, Maschinenbauer, u. s. w.; Sowie zur Benutzung bein Unterrichte Bearbeitet. Erster Teil: Die Konstitution der Eisenlegierungen und Schlacken. By Hanns Freiherr v. Jüptner. Price (paper binding) 13 marks. Large 8°: pp. viii., 316; 11 tables and 10 text illustrations. Leipzig: Arthur Felix.

This first part of a complete work on the science of iron and steel, by the well-known Austrian authority, contains the preliminary part of the subject and treats of the microscopical and chemical constitution of iron and steel alloys and slags.

Sewage.

Report of the State Board of Health Upon the Discharge of Sewage into Boston Harbor. 1900. Transmitted by Sam'l W. Abbott, Secy. Size, 5½ by 9; pp. 87. State Printers.

A review of the subject in connection with the plans for the relief of the towns in the upper Charles and Neponset River Valleys. Concludes that it will generally be more economical to dispose of the sewage of these places by filtration upon land than by conveyance to Boston harbor.

Strength of Materials.

The Winslow Tables. Diagrams for Calculating the Strength of Wood, Steel, and Cast Iron Beams and Columns. By Benjamin E. Winslow. Price, $2.00; 11¾ by 9½; pp. 14, and plates xix. New York: The Engineering News Publishing Company.

A book for the practising structural engineer or architect, furnishing a rapid and easy means of computing sizes of beams and columns by the use of graphical tables. Its aim is to include all ordinary cases without loading the book with problems complicated or of unusual occurrence. The introductory pages are chiefly explanatory or supplemental to the diagrams, with notes on or demonstration of the formulæ on which the tables are based.

Tunneling.

Tunneling. A Practical Treatise. By Charles Prelini, C. E., with Additions by Charles S. Hill, C. E. Price, $3.00. Size, 6 by 9¼; pp. 311. New York: D. Van Nostrand Company

Enlarged from the authors' lecture notes, and explaining all the operations of tunneling with illustration from suitable examples. The book is descriptive, and avoids formulæ and difficult calculations. A very thorough treatise within the scope defined, with 150 diagrams and illustrations.

Water-Supply.

Public Water-Supplies. Requirements, Resources, and the Construction of Works. By F. E. Turneaure, C. E., and H. L. Russell, Ph.D. With a Chapter on Pumping Machinery by D. W. Mead, C. E. Price, $5.00, 21s. Size, 5¾ by 9¼; pp. 746. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

Prepared with reference to the needs of students and teachers rather than as an advanced work for specialists, and therefore concerned with fundamentals rather than details of practice. With this idea many problems, usually treated empirically, are subjected to analysis. Economy in design is emphasized and full treatment given to quality of supplies. Gathers together much heretofore scattered information. Illustrated and well indexed.

Water-Works.

Waterworks Distribution. A Practical Guide to the Laying Out of Systems of Distributing Mains for the Supply of Water to Cities. By J. A. McPherson, A. M. Inst. C. E. Price, 8s. 6d. $2.50. Size, 5½ by 7¾; pp. 154. London: B. T. Batsford. New York: D. Van Nostrand Company.

A somewhat elementary and didactic treatise, addressed particularly to those interested in laying out systems of distributing mains, as well as to students and candidates for examinations. The demonstration is made largely by a hypothetical "example district." Text illustrations and diagrams.

IMPROVED MACHINERY

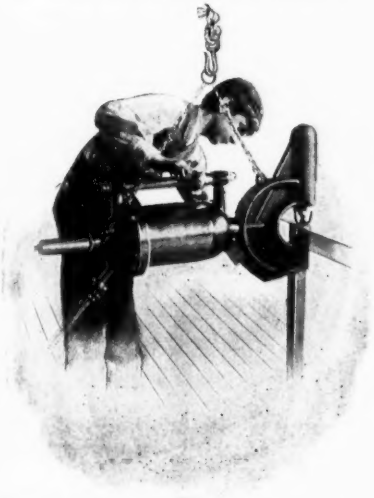
New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Caskey Portable Pneumatic Punch.

THE cut herewith illustrates size 1, pneumatic punch, and the usual mode of operating same. This size weighs 145 pounds and will punch up to 3/8 in. metal. Sizes 2 for 1/2 in. and 3 for 5/8 in. are proportionately heavier, but any of them may be operated by one man, the work of course being stationary. Size 0, or smallest size, weighs 28 pounds, and is adapted to light sheet metal work up to 3/16 in. thick.

It has been found that, under similar conditions, one man moving the punch can do more work, with less liability to error, than three or more men required to move the work while supported by crane on stationary punch, as hitherto.



For manhole work on boilers, uptakes, tanks, stacks, and all work in the field or on board ship in erection, etc., this punch will find a special field, where the need of such a tool has long been felt. Many repairs also, heretofore requiring a taking apart of the whole structure affected, can now be done *in situ*, a fact which ship builders especially will be likely to appreciate.

A further advantage of importance is the saving of floor space effected, the old method of moving the work, obviously requiring just double the space necessary where the work remained stationary while being punched.

The Caskey punch is the first to be operated successfully by compressed air. In construction it is remarkably simple and compact, the chief distinctive feature being a hollow piston containing oil, within a prolongation of which piston, a stationary tube is adapted to telescope, the oil being thereby forced into and through the stationary tube, and thence upon the plunger where it exerts accumulated pressure. The air which drives the piston during the stroke is utilized to drive it back for another, being finally expelled through the exhaust during the next succeeding stroke. This, as will be apparent, effects an important saving in the quantity of air used.

It is built by F. F. Slocomb & Co., Wilmington, Del., from whom any further particulars may be had.

Automatic Dumping Bucket.

THE automatic dumping bucket herewith illustrated is designed to meet the needs of automatic dumping on top of a pile of coal, ore, gravel or other substance, or on a level plane, which it accomplishes in a very creditable manner.

The usual dumping bucket requires a bulk-head or buffer-block to automatically trip the back latch, thus releasing the bucket, and permitting it to dump, as, if the side latch is used it must be tripped by hand; thus additional expense of a man for this purpose. In this new bucket the bail is slotted in such a manner as to permit it to move downward after the bucket is in a state of rest on top of a pile of coal, ore or gravel. This permits the latch on the side

to become disengaged and the bucket immediately dumps, and as it is hoisted into air it rights itself and is locked automatically and returned to hatch of vessel or for refilling by shovelers. When the bucket is being filled there is a small latch in the rear of the bail, which is thrown over in such a manner as to guide the bail; when being lifted up with its load, after the lock is engaged, this small latch is thrown back into such position by one of the shovelers, as to allow bucket to dump when required.

The construction of the bucket is such that it can be dumped by hand if desired.

The bucket is substantially made and far superior to the old type of bucket. Manufactured by the Cornell Machine Company, Chicago, Ill.

The White Star Oil Filter.

It is almost needless to argue upon the desirability, even necessity, of utilizing the oil that is lost in machinery lubrication by reason of its passing through and becoming filled with grit and dirt. In these days when profits are a matter of cents rather than of dollars, no economy, be it ever so small, is overlooked by the wideawake manufacturer. The importance of saving waste oil being generally recognized, the question confronting the manufacturer to-day is the means of its saving—whether it can be so thoroughly, quickly and cheaply done as to justify him in making use of it.

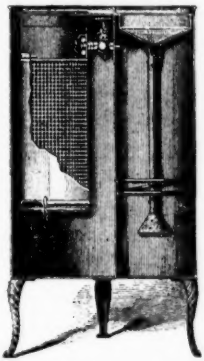
The accompanying illustration shows the unique and original lines upon which the "White Star" oil filter is designed and wherein it differs from other filtering devices. It is divided by a vertical partition into two distinct compartments connected by a pipe with valve and each having a separate lid. This enables the pure oil compartment to be always kept closed, thus avoiding spattering any dirty oil into the pure oil chamber. A small compartment comprising one-third of the entire filter is a receptacle for dirty oil and water and contains a funnel for receiving the oil and a steam coil for heating the water. The waste oil is first emptied into the funnel (the top of which is fitted with a removable sieve) and, descending the funnel tube, is discharged below the surface of the water through holes in the foot of the tube, when it rises.

The thinning of the oil by its exposure to the heat in rising through and resting on the surface of the water, causes the precipitation by gravity of all the heavy particles of grit and dirt which are flushed out at the bottom of the tank. Owing to the large waste oil capacity this precipitation is pro-

lunged for some time, thereby practically purifying the oil before leaving this compartment. This, however, is only preliminary to the actual process of complete filtration obtained in the adjoining chamber.

When sufficient impure oil has been introduced to reach the level of the inlet pipe it flows into the filter cylinder, suspended in the larger compartment, which is a reservoir for the pure oil. The filtering surface of the cylinder is always equal to the area of the cross-section of the entire tank, being much greater than can be obtained by any other arrangement. This, in connection with the peculiar virtue of the filtering cloth, causes the "White Star" to filter completely a large quantity of oil in a given time.

To clean the filtering cloth all that is necessary is to close the valve in the pipe between the chambers, lift the cylinder out and hold it across the top of the filter, permitting any oil therein to run into the funnel through the hole in the neck. After the oil is drained out of the cylinder it is inverted over the funnel, the flange on the cylinder fitting exactly in the opening, thereby holding it in position while taking off or putting on the cloth. The cloth is removed by untying the cords holding it to the cylinder, taking hold of the free end with one hand, steadying it with the other, and pulling

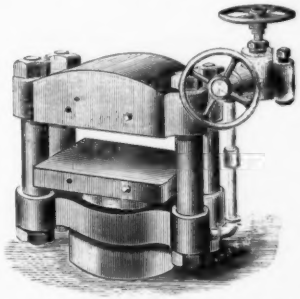


it off, which is easily done, as the cylinder revolves freely in the flange. The cloth removed is immediately replaced by a clean one kept in the pocket in the cover, the operation being in reverse manner to taking off, and is easily and quickly done. The dirty cloth removed is then washed with soaking in lukewarm water, dried, and put in the pocket provided for the purpose.

The Pittsburg Gage & Supply Co., Pittsburg, Pa., who are the manufacturers of this filter, will be glad to send a full descriptive circular of the same upon request.

Hot Die Press.

THERE are some of the plastic materials which have to be heated while under pressure, and for this The Watson-Stillman Co., New York, have built several sizes of hot die presses, in which a non-conductor of heat is introduced between the ram and moving



platen; and in some cases, where high heat is used, the ram is cooled. The top and moving platen are cored out for circulation of steam. The accompanying cut shows the press with combination governing valve, as used for direct-acting steam pump; the outer check valve preventing the letting up of pressure when another press is opened into the line pipe. Iron pipe and swivel joints are used to connect moving platen with the steam stand pipe, which cannot be shown on cut, as they are at back of press.

The manufacturers will give full information as to sizes, special uses, etc., on request.

Water Proof Belting.

Chas. A. Schieren & Co., of New York, tanners and manufacturers of leather belting, have recently installed machinery for waterproofing leather belting.

They are now prepared to waterproof any sizes of belts from the narrowest single ply up to wide main driving belts 72-inches in width, three ply in thickness.

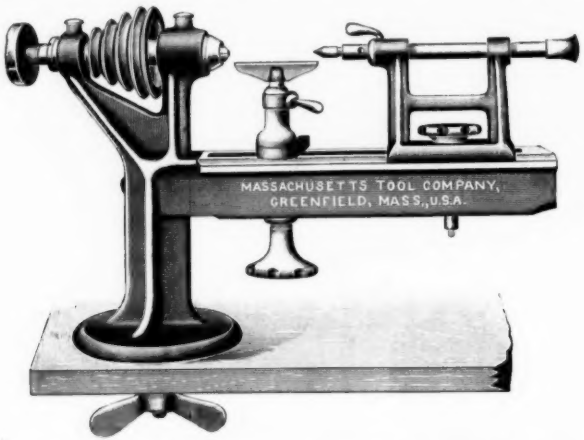
The belts are mechanically drawn through a tank containing 2,000 gallons of water-

proofing material. Belts treated in this manner are not only made absolutely waterproof, but are impervious to steam, and can be run under almost any wet or damp conditions. Belts of this character are also not affected by acid fumes.

Waterproof leather belts are especially adapted for work in saw mills, steam laundries, and dye houses and chemical works, and under conditions in which the ordinary leather belt would not give satisfaction.

Precision Model Lathe.

THE strong feature of the model lathe shown herewith is the high quality of workmanship and materials. There is a large and varied usefulness for a little lathe of this



character among all classes of skilled mechanics and in every shop where small delicate work has to be handled on a machine. The lathe has a 12-inch bed, and swings 5 inches on centers; it is thoroughly well made and in perfect alignment. Manufactured by the Massachusetts Tool Co., Greenfield, Mass.

Electric Train Lighting.

THE Consolidated Railway Electric Lighting and Equipment Company, New York, is supplying the railway companies with a self-regulating and automatic system of electric train lighting that marks a departure in the comfort, convenience and safety of railway travel. This is the result of the consolidation of all the various companies that have for several years past been engaged in bringing the system of train lighting by electricity from the car axle into successful operation. The system, as now perfected, is known as the Consolidated "Axle Light" system, and it is being used on a large number of passenger coaches and private cars of various railway lines throughout the United States.

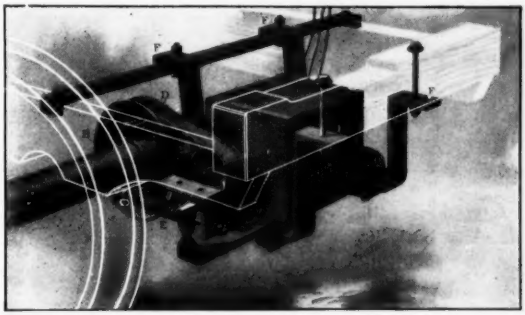
By this system each car is independently provided with its own lighting apparatus, and does not, therefore, depend upon any other part of the train, or upon some distant stationary plant, for its supply of light. The weight of the entire equipment placed beneath the car is considerably less than one thousand pounds.

Under the methods of car lighting where oil lamps and gas globes are used, owing to their size and the heat produced from them, they can only be installed in a few places in the main body of the car, while under the "Axle Light" system the incandescent electric lights and electric fans can be placed in any number, wherever desired, not only in the main body of the car, but in every section and compartment, in the vestibules and on the car platform, so located as to give the best service to the traveling public.

The use of this method of automatically lighting cars by electricity from the rotation of the car axle prevents the possibility of explosion or conflagration in case of a railway accident or wreck. There is at the same time in the use of this system an entire absence of foul air, heat, odor, grease

and dirt, which cause so much discomfort to passengers in cars lighted by oil or gas.

The mechanism of the equipment constituting the Consolidated "Axle Light" system is placed beneath the car, encased and protected from dust and dirt, and no space is occupied within the car. A dynamo is placed beneath each car, and so adjusted that at a speed of fifteen miles an hour it



feeds the lamps direct, the superfluous current being stored in a battery for use when the car is stationary. The dynamo under the car derives its power from the car axle, there being no axle bearings to become heated, and no gears to get out of order. The dynamo maintains a pressure of from thirty-two to forty volts, and is automatically switched into circuit when the speed of the train is fifteen miles an hour, the pressure being so controlled that at all speeds the current supplied to the lamps is uniform.

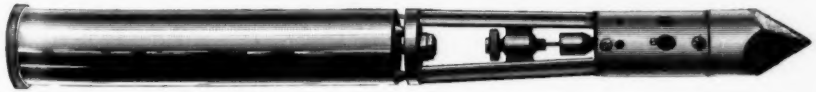
When the car is at rest, and the switch box has switched the dynamo out of circuit, the lights are supplied at thirty volts by the storage batteries.

After starting, as the car gains speed, the dynamo voltage is built up until it has reached a potential above that of the storage battery and the lamps. The latter are prevented from receiving more than thirty volts by means of resistance in their circuit. The lamps are of sixteen candle-power, and the filament is a short, stumpy one, not affected by vibration and, consequently, is long-lived.

The cost of the installation of the Consolidated "Axle Light" system upon each car, all things considered, is not as great as that of other methods of car lighting; its efficiency is of the highest grade, and its cost of maintenance per car per annum is comparatively insignificant, while it furnishes double the candle-power of light produced by oil lamps or gas of any kind. Further details may be had by addressing the company direct.

Self-Heating Brazing Tool.

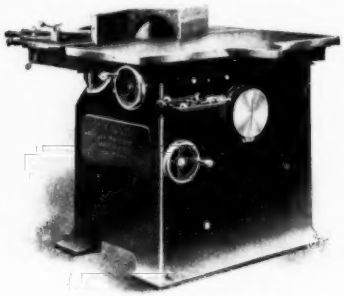
THE Vulcan self-heating soldering and brazing tool is shown herewith. The special points of advantage in this tool are that it consumes about one cent's worth of gasolene for a day's work; the flame can be turned down or out when the tool is not in use, and can be quickly relighted; the copper heads last indefinitely, as they are not damaged by contact with hot coals; heads of different shapes may be used interchangeably on the same tool; and no time is lost in reheating, as the tool is always hot when in use.



Manufactured by the Auto-Tool Mfg. Co., New York.

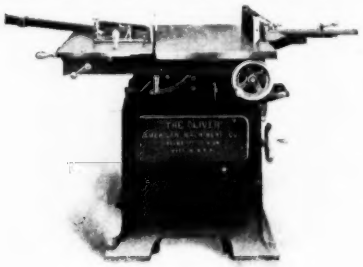
The Oliver Saw Bench.

THE accompanying views show the new Oliver universal saw bench just placed on the market by the American Machinery Co., Grand Rapids, Mich. Chief among the improvements are the dial, which always shows the exact degree at which the table is



tilted; the turning of a handwheel is all that is necessary to tilt the table from a horizontal to any angle up to 45 degrees, and it is unnecessary to do anything to lock it securely in at the desired angle; the double arbor yoke is a heavy casting, cast in one solid piece. The supporting end is 6½ inches in diameter, thus making it very rigid and secure. In addition to this a steady rest or plug is used for the opposite end, thus giving it bearing from both sides.

This machine weighs 1,800 lbs., and is extremely heavy and rigid. Other features

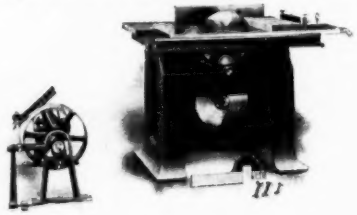


are worthy of attention, and the manufacturers will give full details on request.

The Clayton Fire Extinguishing System.

DURING the past year there has been developed a highly interesting and ingenious system of fire extinguishing based upon the invention of Mr. T. A. Clayton.

The object of the Clayton system is to extinguish fires in inclosed places, such as storehouses, grain elevators, and, above all, the holds of ships. Various reasons have impelled the Clayton Fire Extinguishing & Disinfecting Company of New York to use sulphurous acid gas or sulphur dioxide as the means for extinguishing. Practically all chemical extinguishers depend for their efficiency upon the liberation of carbonic acid gas, and in the popular mind this is generally considered the most effective enemy to combustion. Investigations made demonstrated the rather peculiar fact that quenching a fire by this method is not the result of the attenuation of the oxygen, because various gases require to be added in varying amounts to the atmosphere surrounding a fire before it will be quenched. About 15 per cent. of carbonic acid gas must be injected to quench a brisk blaze. The developers of the Clayton system have found



in their experiments with sulphur dioxide that less than 5 per cent. will accomplish this result, even when the blaze is extremely fierce. Therefore it appears that there is some inherent property in sulphur dioxide which makes it especially valuable for this purpose. The specific gravity of the gas is 2.2 of that of air and 1.5 of that of carbonic acid.

Besides these two superior qualities the fact that the gas can almost instantaneously be developed in large quantities and in a very simple manner led to its adoption. The gas is generated by the combustion of crude brimstone, and in about five minutes after starting the machine every particle of oxygen entering the furnace containing the burning sulphur is being utilized. This in itself is a feature of importance, because when all the oxygen is combined with the sulphur the result is a mixture of only nitrogen and sulphur dioxide, both enemies to fire.

A highly important feature of the system is that after the fire is extinguished the charged atmosphere in the inclosed space or compartment in which the fire was raging is pumped back into the chamber after passing through a cooler. Thus there is added to the fact that the fire is surrounded by an atmosphere incapable of supporting the combustion the fact that the circulation of that atmosphere through the cooler lowers the temperature in the chamber to such a point that reignition is impossible.

The generator used consists of a jacketed furnace in which there are traps upon which the sulphur is burned. In the base of the machine is the cooler, consisting of a series of tubes through which the gases flow. On the same bed plate is the blower, driven by a small engine. The floor space required is 4 feet 6 inches by 5 feet 8 inches.

When it is desired to stop the discharge of further sulphur dioxide into the seat of the fire, and to cool the atmosphere in the chamber, a valve which controls the return from the compartment, is opened and then the blower performs the function of drawing the gases through the cooler again and again, until the temperature is lowered sufficiently.

These operations are carried on by means of a controller so designed as to permit of regulating the amount of oxygen entering into the compartment and at the same time obtain perfect combustion of the sulphur. By its use it is possible to obtain a pure gas at a temperature of less than 100 degrees. This does away with any necessity of lagging the conducting pipes and the men are free to handle the pipes at any point. The system of distributing piping will be simply that of using manifolds provided with valves and controlling the supply and exhaust pipe from each of the compartments, and will be exactly similar to any ordinary system of steam or gas piping. Three inches will be the largest diameter employed.

The Clayton system provides a method not only of extinguishing fires which may occur but it makes it possible, by charging the hold of a vessel with gas, to eliminate any possibility of the ignition of even the most inflammable substances. This latter feature is most strikingly demonstrated experimentally by charging with sulphur dioxide a building containing naphtha, cotton, hay and other combustibles. When white-hot iron plates are lowered into these materials no further action results than the boiling of the naphtha and the charring, without even the slightest trace of smoke or flame, of the solid substances.

The most conclusive proof of the efficiency of sulphur gas as an extinguisher is the successful outcome of a series of exhaustive tests upon cotton bales. Burning cotton makes without doubt the most tenacious and stubborn fire encountered in ships. Water and steam alike are not to be relied upon to stifle such fires, but even when they do conquer the combustion the bale is generally useless because the salvage is almost nil. Sulphur dioxide, on the other hand, so penetrates the bale that extinction becomes a certainty even after the fire has burned freely two hours or more.

Box Elevator.

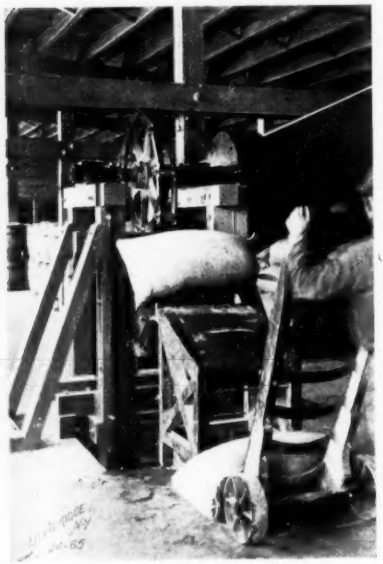
THE empty box elevator here illustrated is from a photo of the machine installed to accomplish this work for the Scott Paper

Co., Philadelphia. It possesses several meritorious features which are worthy of attention.

The economic handling and disposition of

empty packing cases and other empty receptacles often presents most vexatious problems; being light in weight they usually come in lots of large compass, loads of "bulk alone." To get them out of the way and accessibly stored with all possible expedition is not only desirable, but sometimes imperative. Often as much labor and more annoyance is occasioned in accomplishing this as by the handling required after packing.

The device mentioned above is but another utilization of the numerous labor saving applications of what is familiarly known as link belting, and was built by the Link-Belt Engineering Company, of Nicetown, Pa. A double strand of "Ewart" link-belting is employed and at intervals of five feet, a straight arm is attached, one to each "belt." The machine is mounted in a wooden frame and carries empty boxes from the ground to the upper floor of the warehouse at the rate of twelve per minute.



Another application of the same principle, for much heavier work is the link-belt barrel and sack elevator, which is also shown. This machine is provided with automatic arms which permit of barrels and sacks being elevated and gently delivered to any floor, while simultaneously others are being carried down on the other side. The view shown is one from a photograph of the Lehigh Valley Railroad Co., Jersey City freight house. The machine has 37 foot centers and uses heavy malleable iron chains with carrier arms attached at every ten feet. The machine is provided with an adjustable stop so arranged that the barrels are discharged at the proper height to be rolled away on the floor, or the sacks for convenient removal by hand trucks. The head is driven by worm gearing, encased in a housing and the worm runs in a bath of oil.

Mechanical Draft.

MECHANICAL draft, and especially mechanical induced draft, may safely be characterized as the economy factor of modern boiler practice. Of the many advantages following in the train of induced draft none has been so instrumental in causing its rapid introduction and development as the marked savings effected thereby.

The essential feature of mechanical induced draft may be said to reside in the application of a fan between the smoke box and stack to create the draft which is necessary to supply oxygen to the fuel and which it has been the function of the chimney heretofore to produce. In the case of a fan installation the stack ceases to become the draft agent and hence need only be of a height sufficient to discharge the gases so as not to be obnoxious. The heat of the gaseous products of combustion is now no longer necessary, as in the case of the chimney, to create the necessary draft and may therefore be extracted by the agency of economizers or feed-water heaters, thus reducing to a minimum the greatest source of loss which the boiler plant knows.

It will be seen that instead of being a fixed quantity as in the case of a chimney, the intensity of the draft may be varied by means of the fan engine speed. Thus when increased steam consumption or other causes occasion a fall in the boiler pressure, the deficiency may be made good by an extra turn of the fan engine throttle. It often becomes desirable that this regulation for a constant steam pressure should be made automatically, and this is easily accomplished by placing a pressure regulating

valve in the steam pipe of the engine which drives the fan. Such a device may be so adjusted as to cause the fan engine speed and hence the intensity of draft to be increased whenever the pressure tends to fall off, thus giving a very nearly constant boiler pressure.

In these days, however, the steam engine is by no means the only motive agent which is utilized for fan driving. In many situations the electric motor, either belted or direct-connected, has been found to be by far the most suitable arrangement for fan work, being peculiarly adapted to such service by reason of the identity of motion and of the driving and driven portions of such a combination. The application of motors for driving the fans of induced draft plants has involved the problem of speed regulation for a constant steam pressure, as in the case of the steam driven fan heretofore mentioned. This problem has been adequately solved by the Buffalo Forge Company, of Buffalo, which company in its various mechanical draft installations is now able to arrange for automatic control of the fan motor speed. This is effected of course through the medium of a special motor-controller actuated by fluctuating boiler power. In this way exceedingly close regulation of the boiler pressure can be obtained with a minimum need of attention on the part of the fireman though, of course, it is not to be implied that the latter individual under such arrangements need become simply a figure-head.

Industrial Notes.

Henry Maurer & Son beg to extend to all engineers and architects visiting the Pan-American Exposition, a cordial invitation to inspect their exhibit of clay products for building and other purposes, assuring them of a hearty welcome. To those engaged in fireproof construction, as well as to those branches of manufacturing requiring a high grade of fire-brick, much will be found of interest.

American Tool & Machine Co., Boston, Mass., has moved its New York office to the St. Paul Building, 220 Broadway. Mr. G. F. Kenney remains in charge.

On the recommendation of the Franklin Institute, the silver medal and diploma was awarded by the National Export Exposition to the International Correspondence Schools, Scranton, Pa., for a unique, thorough and comprehensive system of technical education by correspondence.

Mr. H. F. J. Porter, formerly manager of the Chicago office of the Bethlehem Steel Company, and more recently located at the works at South Bethlehem, has been appointed New York sales agent of the company, with headquarters at 100 Broadway.

The Weston Electrical Instrument Co. have moved their factory from Newark to Waverly Park, Essex Co., N. J.

One of the notable recent electric contracts is the one awarded to the Stanley Electric Manufacturing Company, of Pittsfield, Mass., by the Castner Electrolytic Alkali Company, of Niagara Falls, N. Y., for eight S. K. C. Motor Generators, each set having a direct current output of 500 kilowatts. These machines will take the current from the Niagara Falls Power Co., at 2,200 volts, 25 cycles, converting same into direct current of 245 volts for electrolytic work. The contract includes a complete switchboard equipment for handling the 8,500 kilowatts.

The newly completed Olympia Mills at Columbia, S. C., designed by W. B. Smith Whaley & Co., have been equipped with a somewhat novel arrangement of the blower system for heating and ventilating. Two 14-ft. Sturtevant fans force the unheated air through horizontal underground ducts extending along both side walls. Branches from these ducts connect with vertical flues built in the side walls and deliver air to the various floors. Instead of the usual coil arrangement at the fan, Sturtevant standard corrugated sectional base coils are placed in the main ducts where the flues connect with them. This arrangement was used in order that the amount of heat supplied to any part of the mill building could be controlled without affecting the air supply. It also saves the loss of heat in the main ducts in the basement and permits the use of slightly smaller ducts on account of the lower temperature of the air. All apparatus for this system was furnished by the B. F. Sturtevant Co., of Boston, Mass.

Stanley Electric Manufacturing Company, of Pittsfield, Mass., have established

a branch sales office at 26 South Fifteenth street, Philadelphia. Mr. James E. Cutler, late of the New York office, has been appointed district manager.

The office and business of the Wright Manufacturing Co., manufacturers of high grade steam specialties, Cleveland, Ohio, have been removed to Detroit, Mich., where the business of the company will hereafter be transacted.

Western Electric Company, Chicago, is receiving an exceedingly heavy demand for fan motors this season. It is claimed their total sales thus far for 1901 have by far exceeded those of any previous year. The demand from foreign trade is especially heavy, unusually large orders coming from India.

The New Process Raw Hide Co., Syracuse, N. Y., has recently added considerably to its equipment by the purchase of new machinery, including three bevel gear planers, which plane the teeth accurately to cone lines, and an additional automatic spur gear cutter, and is now in the market to make metal gears to order in addition to its "New Process" noiseless pinions.

Owing to the determination of the United States Steel Company to concentrate all operating departments of the constituent plants at Pittsburg, Charles M. Jarvis, vice-president, in charge of the operating department of the American Bridge Company, has resigned, as Mr. Jarvis does not care to change his residence from New England.

The H. W. Johns Manufacturing Co., New York, have secured a number of contracts for application of their asbestos coverings, among which are the following: U. S. S. Illinois, insulation under protected deck; Am. Aristotype Co., Jamestown, N. Y., fire felt sectional covering and cement felting; Syracuse Rapid Transit Co., Syracuse, N. Y., fire felt sectional covering; covering of pipes at the residence of C. F. Deterin, Millburn, N. Y., for Hitchings & Co., has been completed, Asbestocel covering used; covering of heating pipes at Museum of Art, New York, has been completed; Asbestocel covering has also been used throughout the entire plant of the Scoville Manufacturing Co., Waterbury, N. Y.; the contract has also been awarded the Johns Co. for covering all high pressure and heating lines at Atlantic Mutual Building, Wall and William streets, New York, where Asbesto-Sponge moulded covering was used; United & Globe Rubber Manufacturing Co., Trenton, N. J., Asbestocel covering; National Conduit Co., Hastings; Lister Agricultural Chemical Co., Newark, N. J., and Albany Iron Works, Troy, N. Y., fire felt coverings; Asbesto-Sponge moulded covering used in school at Fordham, N. Y.; fire felt sectional covering used at Queens Borough Electric Light & Power Co., Far Rockaway, N. Y., as well as at the Fair Haven & Westville R. R., New Haven, Conn., and Olympia Cotton Mills, Columbia, S. C.; Asbestocel coverings used in Willard's Hotel, Washington, D. C.

The Bullock Electric Manufacturing Co., of Cincinnati, and the Wagner Electric Manufacturing Co., of St. Louis, have effected a combination of their selling organizations. The product of the Bullock company consists of a complete line of direct and alternating current machines from a half horse power motor to a 10,000 K. W. generator, controllers of various types and rotary transformers. The product of the Wagner company covers a full line of static transformers, ammeters, voltmeters, wattmeters, switchboards and single phase self-starting alternating current motors.

Crane Co., Chicago, manufacturers of valves, fittings, etc., has decided to erect this summer a modern fire-proof building exclusively for offices. It will be about 90 ft. by 100 ft., five stories and basement, and will be located in the vicinity of its large cast iron and malleable fitting and valve works, at Canal and Twelfth streets.

The American Engineering Works, of Chicago, has recently received a number of export orders for mining and industrial cars to be equipped with their patent Anaconda wheels and axles. These orders have been from England, Japan, Mexico, British Columbia and Alaska. This company is also filling a number of export orders for shells for crushing rolls made from their special A. E. W. steel.

The Fox Machine Co., of Grand Rapids, Mich., will exhibit their wood and iron working machinery at the Pan-American, Block 38, Machinery Building, the exhibi-

tion including, in iron and tools, shapers, light milling machines, multiple drills, planer chucks and pipe cutters, while the wood working tools consist of wood trimmers, miter machines and dado or grooving heads. The Fox Machine Co. were the pioneers in the manufacture of wood trimmers for pattern work. The Fox typewriters also form an interesting feature of this exhibit.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

EDSON MFG. CO., Boston, Mass.—A very attractive booklet illustrating an improved pile sinking outfit for constructing wharfs, piers, jetties, and fishing weirs.

THE WATSON-STILLMAN CO., New York, N. Y.—An "Illustrated Index" of hydraulic tools and miscellaneous machinery manufactured by this company. No descriptive matter accompanies the cuts, but a number refers to the page in the regular catalogues of Watson-Stillman Co., in which detailed illustration and description may be found.

GREEN ENGINEERING CO., Chicago, Ill.—Catalogue B illustrating and describing in detail the Green traveling link grate, a form of mechanical stoker. Much interesting information and several valuable tables for coal users are given in the back of the book.

MONARCH MFG. CO., Waterbury, Conn.—Fully illustrated catalogue of a device for stopping steam engines and other motors from one or several points, near or remote from the engine room, by pressing an electric button, or automatically by speed-limit in case of over-speed.

PAUL H. WHITE ENGINEERING WORKS, Indianapolis, Ind.—Small booklet relating to steam automobiles for heavy trucking. Maintenance prices of the trucks in comparison with animal traction lend additional interest to this catalogue.

THE EDDY ELECTRIC MFG. CO., Windsor, Conn.—Bulletin No. 18, referring to a general line of motors, generators, and direct-connected sets.

YORK MFG. CO., York, Pa.—A handsomely printed catalogue in two colors giving detailed information about ice-making, refrigerating, and a large line of special machinery manufactured by this company.

NEWTON MACHINE TOOL WORKS, Philadelphia, Pa.—Catalogue No. 34. An extensive line of railway and general machine shop tools.

PARKER ENGINE CO., Philadelphia, Pa.—A small catalogue of the Parker steam generator, a water tube boiler possessing many interesting features.

NARRAGANSETT MACHINE CO., Providence, R. I.—A "temporary catalogue" of lockers intended for general machine shop and factory use.

WM. H. EDDY CO., Worcester, Mass.—Booklet describing a line of turret chucking lathes and machine tools.

SPRINGFIELD ENGINE STOP CO., Springfield, Mass.—Descriptive catalogue of electric engine stops, speed limits, vacuum breakers, and flexible blocks. Many illustrations give a clear idea of the application of this stop in several well-known steam plants.

SCHLICHT COMBUSTION PROCESS CO., New York, N. Y.—A handsomely printed pamphlet of the Schlicht furnace adapted to industrial uses.

BALL BEARING CO., Boston, Mass.—A brief catalogue illustrating applications of ball journal bearings and ball thrust bearings to machines and vehicles.

BENEDICT & BURNHAM MFG. CO., Waterbury, Conn.—A small pamphlet describing the advantages of Benedict-Nickel seamless tubing for feed-water heaters and condensers.

O. S. WALKER & Co., Worcester, Mass.—An attractive little brochure on magnetic chucks for use on iron planers and surface grinders to hold, without the use of bolts, straps, or jaws, all classes of iron work having flat sides.

AMERICAN BELT-FASTENER Co., New York.—Leaflet describing A. B. C. metallic belt lacing designed to provide a short flexible joint which will not open, and is noiseless.

ELECTRIC BOILER PROTECTION Co., New York.—A folder referring to the Mathews electric alarm cock designed to be attached to a boiler and to give an alarm in any part of the building or vessel and in as many places as may be desired.

AMERICAN ENGINEERING WORKS, Chicago, Ill.—A descriptive bulletin of steam stamps offering advantages of small initial cost of installation and large capacity for size and cost.

GENERAL TELEPHONE Co., Boston, Mass.—Booklet giving reasons for installing telephones in factories, mills, machine shops, etc.

CHAS. A. SCHIEREN & Co., New York, N. Y.—A folder illustrating some 72-inch three-ply belts manufactured for electric power and traction plants.

CHAS. J. BOGUE, New York, N. Y.—A catalogue of electrical projectors and search lights intended for marine use.

THE WELLMAN-SEAVER ENGINEERING Co., Cleveland, Ohio.—A large and very complete bound catalogue illustrating buildings and structural work, cranes, electric ingot strippers, blast-furnaces, coke-oven and coal handling machinery, cement works, and special hoisting and traveling machinery installed by this company. The illustrations are exceptionally fine, and very much interesting detail is given.

WAGNER-PALMROS MFG. Co., Fairmont, W. Va.—Bulletin No. 1 announcing the organization of the Wagner-Palmros Mfg. Co. for the purpose of building machinery and supplies for use in and about coal mines and coke plants.

AUTOMATIC MACHINE Co., Greenfield, Mass.—A handsome booklet showing a very extensive line of automatic screw machines, speed lathes, and cutter grinders.

MORSE TWIST DRILL AND MACHINE Co., New Bedford, Mass.—A very complete catalogue of an extensive line of constant angle twist drill chucks, reamers, taps and dies, and machinists' tools.

JOSEPH T. RYERSON & SON, Chicago, Ill.—Brochure describing in detail corrugated furnace boilers with Morison suspension furnaces for land and sea.

STANLEY ELECTRIC MFG. Co., Pittsfield, Mass.—Bulletin No. 117 descriptive of the S. K. C. indicating wattmeter and S. K. C. phase indicator. These instruments depend upon the dynamometer principle and are of the spherical coil type. No allowance has to be made for a lagging or leading load, as the wattmeter indicates power directly.

GOODELL-PRATT Co., Greenfield, Mass.—A handsome and extensive catalogue of a variety of drills and tools for wood and metal working.

PERFORATED PLATE SCREENS

AS REQUIRED FOR

STONE, ORE, ZINC, LEAD and all Railroad and Mining Uses.

SPECIAL SCREENS FOR COAL AND COKE.

THE HENDRICK MFG. CO., LTD.,

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Carefully go over and re-arrange your Advertising; re-design some of the cards that have become stale and need "toning up;" perhaps a new and up-to-date engraving is necessary.

Drop such advertisements as you have reason to believe "don't pay."

Possibly you are not represented in some "growing industry" that is worth working.

How about your Export advertising? This is very important now.

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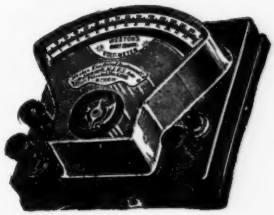
Counselors and Attorneys in Trade Journal Advertising. Pioneers in the business. Established 1877. Consultation Free.

WESTON STANDARD PORTABLE

VOLTMETERS, AMMETERS, WATTMETERS.

Strictly high-grade. Recognized as Standards.

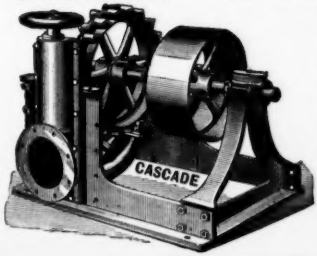


Weston Electrical Instrument Co.,

Waverley Park, Essex Co., N. J.

BERLIN: European Weston Electrical Instrument Co., Ritterstrasse, 88.
LONDON: Elliott Bros., 101, St. Martin's Lane.

TURBINE AND CASCADE WATER WHEELS



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Our experience of **39 YEARS** building Water Wheels enables us to suit every requirement of Water Power Plants. We guarantee satisfaction.

Send for a Pamphlet of either Wheel and write full particulars.

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More than 1,250,000
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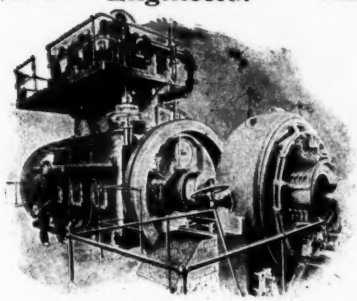

Plants Installed.

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Complete Power Plants for all kinds of industries designed and installed under one management.

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Engine-type Generators connected Electrically to Step-up Transformers in Main Power Stations and Step-down Transformers and Rotary Converters in Sub-Stations, as approved by the latest and best Engineering practice.

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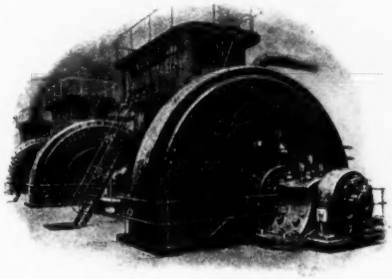

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The Standard of Electrical Efficiency.

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All Principal Cities in U. S. and Canada.

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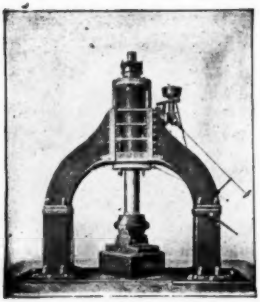

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William Sellers & Co. Incorp.

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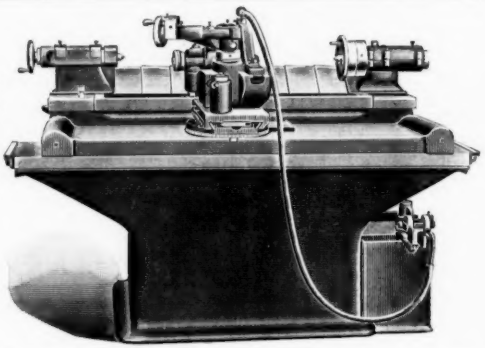
STEAM HAMMERS.

Note.—We show herewith a 2¼ ton Hand-Acting Steam Hammer with Bed and Anvil Block in position.
Takes Steam above and below Piston.
Has balanced Piston Valves and Patent Exhaust arrangement.

Now This is

A rear view of our No. 3 UNIVERSAL GRINDING MACHINE—a universal favorite. Maybe you are losing money by not knowing about our Grinder. Several people are.

Ask for Free Pamphlet Telling How.



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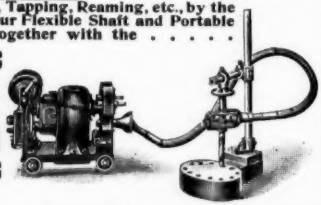

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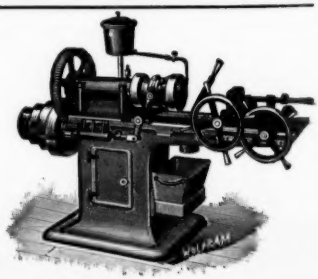
Acme Single, Double and Triple Automatic Bolt Cutters, Cutting from ⅛ inch to 6 inch diameter.

Also Separate Heads and Dies.



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